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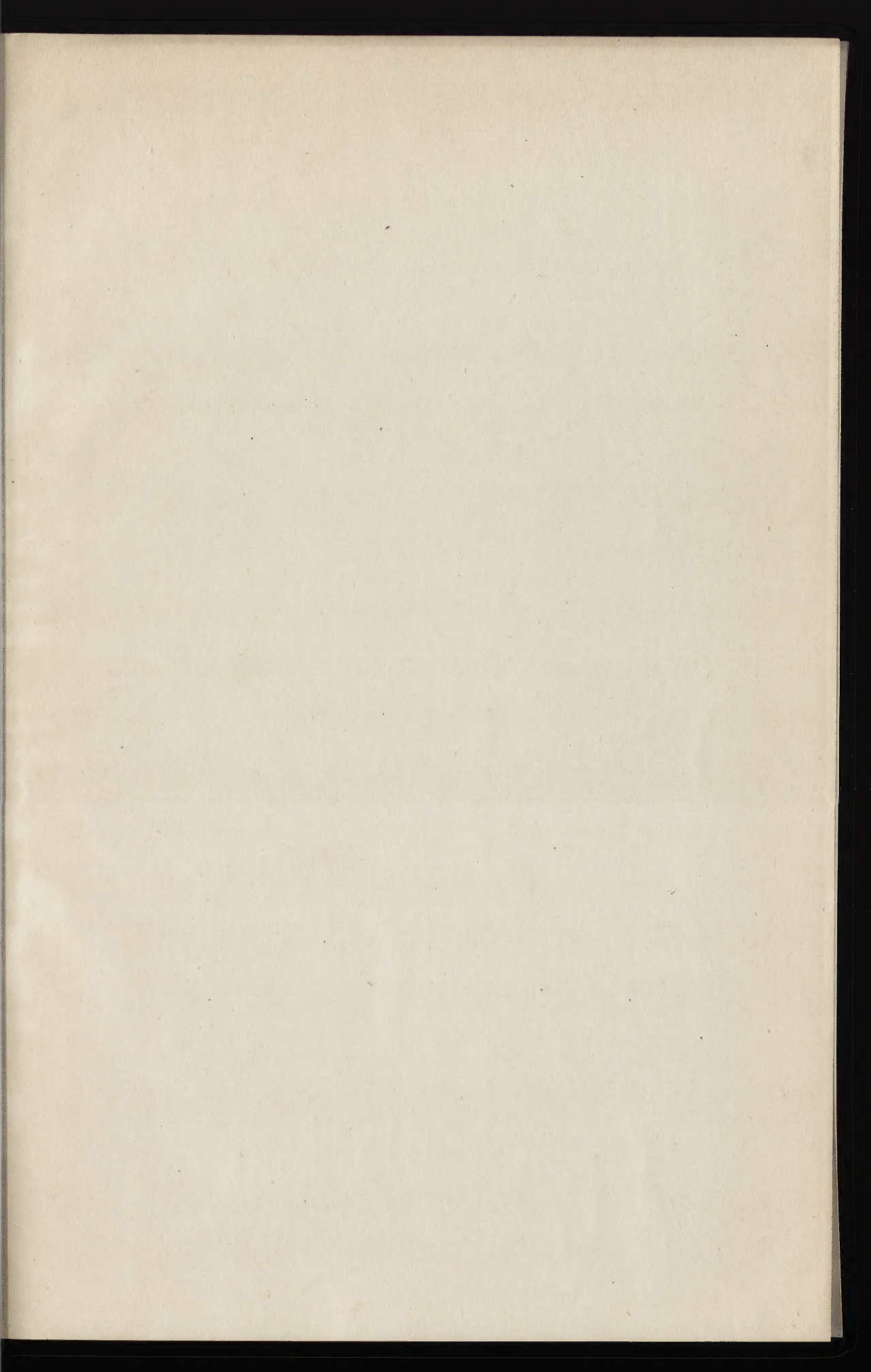
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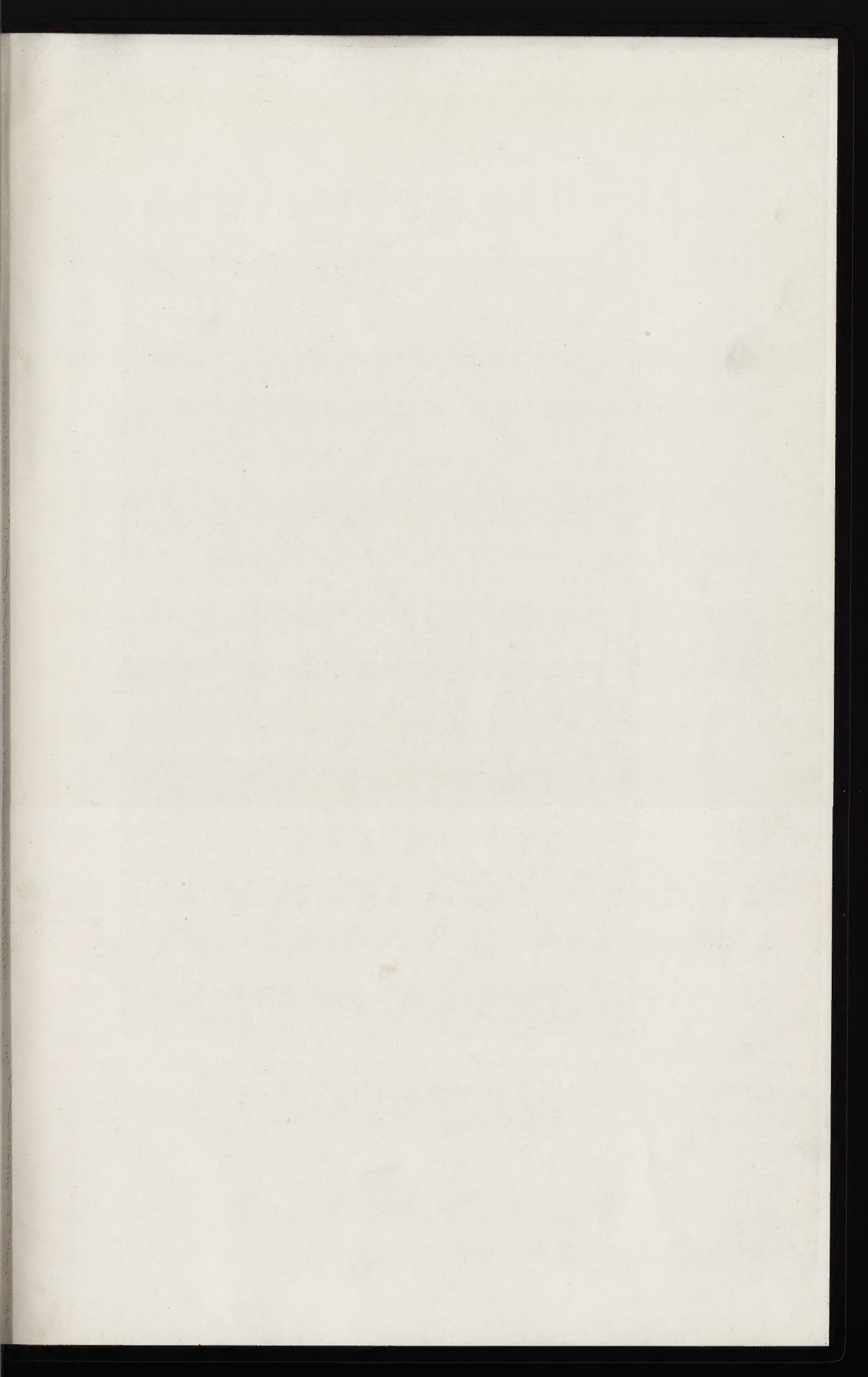
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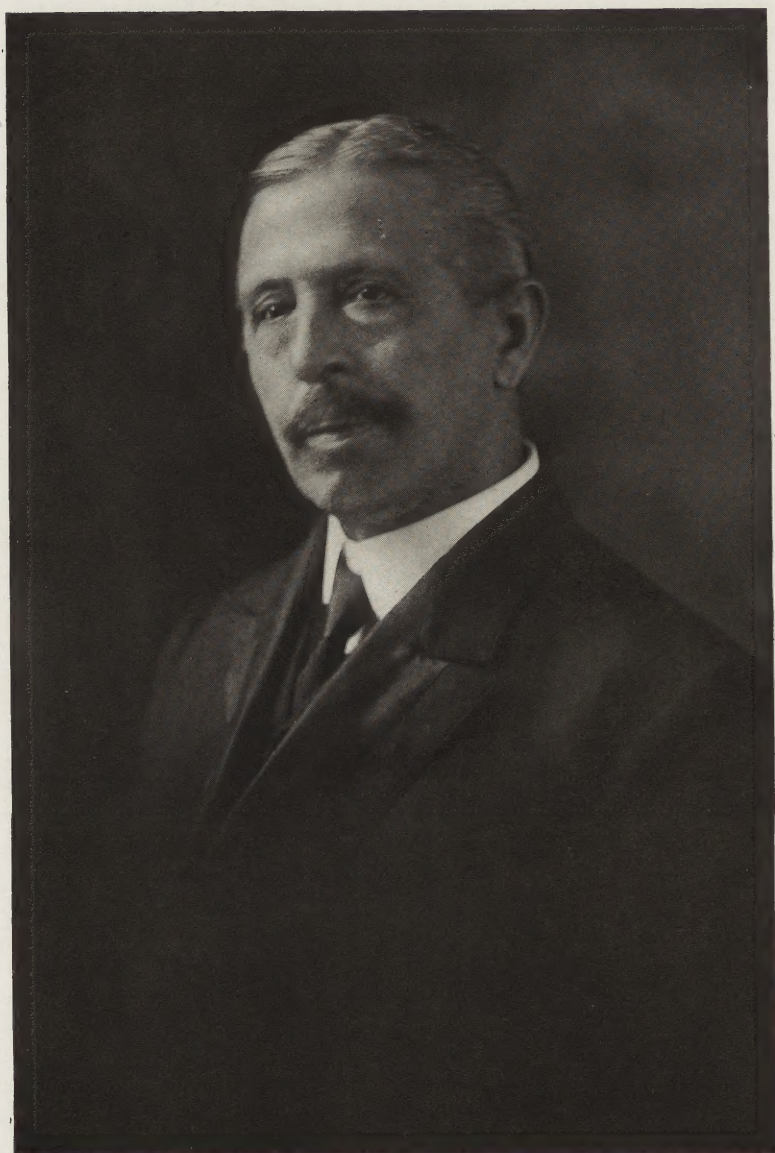
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George Hober;

THIS NUMBER IS PRINTED IN HONOR OF

THE 70th ANNIVERSARY

OF

DR. GEORGE M. KOBER

Associate Editor of this Journal

BY HIS

FRIENDS AND ASSOCIATES

MARCH—1920

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BIOGRAPHY OF DR. GEORGE M. KOBER

The story of Dr. Kober's life falls into three periods, the period of his Army activities, his period as teacher, practitioner and scientific investigator, and the period of his social activities as philanthropist.

Dr. George Martin Kober, the son of Jacob and Dorothea (Behr) Kober, was born at Alsfeld, Hessen-Darmstadt, Germany, on March 28, 1850. He received his early education at the public and grand-ducal Realschule of his native town, and emigrated, at the age of seventeen, from Germany to the United States in 1867. Shortly after his arrival he entered the Hospital Corps of the United States Army at Carlisle Barracks, Penna. In January, 1870, he was appointed hospital steward and ordered to Frankford Arsenal, where he remained until September 1871, when he was ordered to the Surgeon General's Office, Washington, D. C. During this period his preceptors were Dr. J. J. B. Wright, U. S. A., and Dr. Robert B. Burns, Philadelphia. In the fall of 1871, he entered the Medical Department of Georgetown University where he came under the instruction of such physicians as Drs. Johnson Eliot, Noble Young, S. C. Busey, Francis A. Ashford and Robert Reyburn, and received his medical degree in March, 1873. The following winter, he was the first graduate from a post graduate course instituted at Columbia Hospital, D. C. In the spring of the year, in opposition to the proposal to establish a German dispensary, he helped to reorganize the "Central Dispensary" with a special German-speaking staff. During these three years, he was serving as a hospital steward detailed in a clerical capacity in the Surgeon General's Office, where he rendered valuable aid to Dr. Billings in indexing and classifying titles in German medical periodicals. In July, 1874, he was appointed Acting Assistant Surgeon in the United States Army, remaining on duty in this capacity until November, 1886. During this period, he was Post Surgeon at Alcatraz Island, California, July to November, 1874; post surgeon at Fort McDermit, Nevada, up to July, 1877, during which time he took part in the southeastern Nevada expedition against hostile Indians in the fall of 1875, and in the Nez-Percé expedition (1877); from July to October, 1877, he was in charge of the field hospital at Kamiah on the Clearwater, Idaho; was subsequently post surgeon at camp near Spokane Falls and Fort Coeur d'Alène to November, 1878-1879, Fort Klamath, Oregon, to June, 1880, and Fort Bidwell, California, to November 1886. In post orders No. 104, relieving him from duty at the latter station in November, 1886, the post adjutant states:

"In recognition of the long and faithful professional services rendered to the government during the past twelve years in the field in pursuit of hostile Indians and at various posts, the commanding officer cannot part with him without some expression of his feelings of regret, as part of this service was rendered under his immediate command.

"His devotion to his professional duties has been warmly recognized not only by this commanding officer, but by others and has stamped him as one of the most skillful surgeons in the U. S. Army."

While at Fort Bidwell, he was also engaged in medical practice among the civilian population, remaining at this station until June, 1887, when he traveled extensively in America and Europe, returning to Fort Bidwell the following year. In the fall of 1889

he settled again in Washington, D. C., and in 1889 was appointed Professor of State Medicine in Georgetown Medical College. In August, 1890, he was honorary secretary of the Section of Medical Geography and History in the 10th International Congress. In December, 1890, he returned to Fort Bidwell, where he engaged again in the practice of medicine and where on June 1, 1893, he became once more Attending Surgeon at the post.

During his army period, he became keenly interested in the physical anthropology of the North American Indians, which gave him a natural interest in the work of anthropological societies. At the suggestion of Lieut. Colonel George A. Otis, Curator of the Army Medical Museum, he sent to Professor Rudolf Virchow a collection of Indian crania which are described in Virchow's "*Crania Ethnica Americana*."

In the fall of 1893, Dr. Kober returned to Washington where he has since been one of the most prominent physicians in the city. In 1889, he became president of the Medical and Surgical Society of the District of Columbia and has been Dean of the Medical Department of the Georgetown University since 1901. He was also president of the Medical Association of the District of Columbia in 1898, of the Medical Society of the District of Columbia in 1903, of the Association of American Medical Colleges in 1907, of the National Association for the Study and Prevention of Tuberculosis in 1915 and of the Washington Sanitary Improvement Company since 1916. He has been three times president of the Anthropological Society of Washington, in 1906-7, 1918-19, and 1919-20. He was president of the section on industrial and occupational hygiene of the 15th International Congress on Hygiene and Demography, chairman of the sub-section on sociological medicine at the Second Pan-American Scientific Congress (1916) and is an honorary member of the Association of American Physicians and also of the Association of Military Surgeons. Dr. Kober is a member of the advisory council of the American Association for the Advancement of Science, fellow of the American Medical Association, member of the Cosmos Club, Vice President of the Washington Academy of Sciences, Vice President of the Board of Charities and President of the local Social Hygienic Association.

During his long and useful life, Dr. Kober has written several medical books and over 240 journal articles in the American periodicals. His first contributions to medicine were an essay on Infantile Paralysis, published in the *Pacific Medical Journal* in November, 1874, and a small 100-page book on *Urinology*, reprinted from the *Richmond and Louisville Medical Journal*, 1874, xviii. This was followed by treatises on *Milk in Relation to Public Health* (1902), *Industrial and Personal Hygiene* (1908), *Water Supply* (1908), *House Sanitation* and in 1916 his ardent labors for the improvement of the hygiene of occupations were brought to a focus in his treatise upon *Diseases of Occupation and Vocational Hygiene*, which he edited with Dr. William C. Hanson. This treatise is also of considerable interest to anthropology. His contributions to the periodical literature of medicine and related sciences are of the most varied character, covering such themes as the *Medical Geography, Diseases and Climate of Surprise and Goose Lake Valleys, California*, 1886, the *Relation of Soil and Water to Health and Disease* (1894-96), the *Place of Military Medicine and Surgery in Ordinary Medical Education* (1897), the *Effect of Modern Firearms in War* (1899), the *Canteen* (1903), his study of 330 outbreaks of milk-borne diseases (1901), his long report on butter and butter substitutes (1902), two notable papers on the progress and achievements of public hygiene (1897), and the history of hygiene in the 19th century (1901). In 1875, he published notes on treatment of chronic dysentery with potassium chlorate lotion and of tubercular adenitis

with injections of carbolic acid and glycerine. In October 1876, he described an important case of recovery from gunshot injuries of knee joint which had been treated with antiseptic injections of iodine and carbolic acid. Dr. Kober was also one of the earliest to emphasize the importance of flies as transmitters of disease (1892) and in his report on typhoid fever in the District of Columbia (1895), he definitely located the fact of fly transmission in connection with a house epidemic of typhoid from box privies.

During the last 25 years of his life, Dr. Kober has not been engaged in the actual practice of medicine and has devoted his attention to work in public hygiene, social welfare, and anthropology. His demonstration of the transmission of typhoid fever by flies in a local epidemic, an investigation made at the request of the Health Officer, D. C., was the starting point of these activities. By public addresses and by individual researches into the relative merits of sand and mechanical filtering of water, he did much to secure proper legislation and appropriations from Congress in aid of a proper water supply and sewage system for the District of Columbia. His tabulation of 330 milk-borne epidemics (1901), his writings on industrial hygiene, particularly on the effects of diminished atmosphere upon the health of aviators (1916) and his very active labors in aid of securing better housing for the working classes in Washington are all in the same trend. As a member of the Board of Directors of the Associated Charities, he became interested in the removal of slums and the improvement of habitations for people in less than moderate circumstances. Thus he was one of the principal promoters of the Washington Sanitary Housing Companies, organized in 1897 and 1904, which have provided sanitary homes at reasonable rentals for over 800 wage-earners and their families. This work led to further improvements in sanitary housing in the District and in other cities and Dr. Kober had the gratification of receiving the award of a gold medal at the Paris International Exposition in 1900 in appreciation of these activities. His report on housing of the laboring classes was published in the same year (1900), and his history of the housing movement in the city of Washington in 1907.

Dr. Kober also designed the Tuberculosis Hospital for the District of Columbia, and was awarded a Medal at the Exposition connected with the Sixth International Congress on Tuberculosis, held in Washington, September 28th to October 5th, 1908. In the same year he was also a Member of President Roosevelt's Homes Commission, and in addition to his *Monograph on Industrial and Personal Hygiene*, prepared a *Report on Social Betterment* containing among other articles a plea for the prevention of permanent disabilities in childhood.

Dr. Kober's life has been one of untiring labor, of devotion to duty, of loyalty and gratitude to his adopted country, of many-sided interests, of obstacles triumphantly overcome. The essential trait in his life history has been a sincere interest in the public good. In the city of his adoption he has been identified with almost every movement which has had to do with social hygiene and the well-being of his fellowmen. A public-spirited man in the truest sense, he has been one whose approaches have always been accessible where any enterprise of social moment had to be carried through. People come to him naturally for help of this kind. What he has done has been accomplished not reluctantly or for self-advertisement, but unobtrusively and with a good-natured disregard for the demands made upon his time.

In anthropology, his chief interests have been in demography, racial pathology, and somatology. His publications give no adequate idea of his interest in these lines; but this has found appreciation in his repeated election to the presidency of the local anthropological society, in addition to which he served as a member of the Organizing Committee

of the Nineteenth International Congress of Americanists and as a member of the first Committee on Anthropology of the National Research Council. Besides which he has been one of the Associate Editors of the AMERICAN JOURNAL OF PHYSICAL ANTHROPOLOGY, since the establishment of the JOURNAL.

That the beneficent activities of Dr. Kober may be continued far beyond the scriptural span of life is the hope and wish of his many friends.

American Journal of Physical Anthropology

VOLUME III

JANUARY-MARCH, 1920

NUMBER 1

OBSERVATIONS ON THE NEGRITOS OF THE PHILIPPINE ISLANDS

PHILIP NEWTON, M.D.

Assistant Professor of Anatomy, Georgetown University

FROM THE DIVISION OF PHYSICAL ANTHROPOLOGY, U. S. NATIONAL MUSEUM

EDITOR'S NOTE.

Dr. Newton's work on the Negrito forms a part of the anthropological investigations carried on in 1912-14 under the writer's direction for the Smithsonian Institution and the Panama-California Exposition (1914-15). A brief note of these investigations was published in the Proceedings of the National Academy of Sciences, 1916, II, 32-37. Their main object was, besides the gathering of original material for the anthropological exhibits of the Exposition (now housed in the San Diego Museum), the initiation of a study of the child among various primitive human groups. Together with the child, however, it was necessary to examine as large series as obtainable of the adults in order to establish suitable basis of comparison, and the present report of Dr. Newton deals with his observations on the adult Negrito. Detailed measurements and data, including those on the 75 Negrito children that could be examined, will be published in the future.

Dr. Newton's letter of transmittal of his report seems interesting enough to be included with his article. It follows below. It may only be mentioned in addition that Dr. Newton was selected for the difficult task of a study of the Negritos not only as a medical man and anatomist, but also for his prolonged previous activities in the Philippines.

Letter of Transmittal

WASHINGTON, D. C.,
October 22, 1912.

DR. ALEŠ HRDLIČKA,

Curator, Division of Physical Anthropology,
United States National Museum.

Sir: I have the honor to report as follows on my trip to the Philippine Islands:

I left Washington on May 5, 1912, and arrived at Manila June 4. Returning, I left Manila on September 15, and arrived in Washington October 22, 1912.

I was in the Philippine Islands 103 days. Of this time 65 days were spent in actual field work. The remaining time was unavoidably lost in Manila on account of storms and an attack of dengue fever.

Measurements: More than one thousand negritos were seen. Of this number, over 400 were measured and carefully observed. Practically all of the pure-bloods that could be found were measured, with about 50 mixed-bloods. These mixed-bloods were mostly a division of the negrito called Bataks, living on the Island of Palawan. They have sometimes been considered a separate strain, but actually represent only another admixture of the negritos with Malay blood.

Among the pure-bloods the male adults and near adults numbered 190, the female 83, the children of both sexes 75. The excess of men over women and children is accounted for as follows: The men would frequently travel long distances to meet me when it was impossible for myself to cover their territory. On these occasions very few women and children accompanied them. In addition, the number of children per family among the negritos is surprisingly small.

Photographs: Films of any kind are absolute failures for tropical field work. This will be readily understood if it is remembered that a film must be developed within one week from the day it is taken from the tin in the tropics, and that films require a developing bath with a temperature not over 80° F. There was no ice to be had in the field, and the water was always warmer than 80°. On the other hand, it was impossible to get the films to Manila within the week limit. For this reason, almost sixty per cent of the films spoiled. Three hundred pictures were taken. Most of these were taken in the open and in the rain. The best results were obtained in Palawan among the Bataks, where ice was obtained within the week limit. Seventy-two good pictures were ruined when my boat was upset in the Cagayan River during a severe storm.

Plaster Casts: Sixteen attempts were made to secure casts, but they were all failures. Like the photographs, most of these were made in the open and in the rain. One hundred pounds of the best dental plaster was taken by me from the United States. This was packed in supposedly airtight cans, but when it was opened it had either absorbed moisture, or else absorbed a large quantity in a very few moments, because it had neither the feel nor look that it should have had. A can of plaster was purchased in Manila, but this yielded no better results. I was informed by several physicians that plaster was little used for fracture-casts in the Philippine Islands on account of the great difficulty in keeping it dry.

In several cases the plaster was given an hour to set, but the masks always broke when being removed. Casts were made twice as thick as ordinary, but even these were failures. I believe that plaster can be satisfactorily handled only during the dry season when the air is not saturated with moisture.

Skeletal Material: The negrito will not willingly part with the remains of his dead, and this part of the work was very difficult. In addition to the opposition on the part of the negritos, the graves themselves are widely separated and in the most out-of-the-way places. When found they must be opened at night to escape the watchfulness of the negritos. As it rained practically every night this work was done under the most adverse circumstances.

Twelve graves were opened—the locations of seven were given by a half-breed—, three were discovered by me on my travels, and two more were located by a Filipino. The locations of seven more graves became known to me, but I could not open them on account of the negritos' watchfulness.

Of the twelve graves opened, but one yielded results. From this a skull, part of a femur, and some vertebrae were obtained. This body had been in the ground less than six months. In the case of the other bodies, which had been in the ground from one to six years, the bones were all in the last stages of decay and nothing of value could be saved. This rapid decay is accounted for by me as follows: Many of the mountainous regions have a great deal of lime in their geological makeup; the negrito body is buried only about two feet deep, and without any form of covering, which allows both the surface heat and surface water to attack it very rapidly.

Weather: The months of my stay in the Philippines proved, accidentally to be the worst ones of the entire year. It rained every single day and typhoons were numerous. The negritos have no houses, consequently most of the work had to be done in the open. Travel was very difficult during this rainy season, the mud frequently measuring from six inches to a foot in depth.

Food and Payments: All the food used by me had to be carried with me. Likewise, to secure the good will of the negritos, I had to feed them. This item of rice for the negritos, with its transportation, was expensive. No cash payments were made, the negritos being satisfied with food, a few beads, red-cloth, and tobacco.

Data: The negritos answered freely all questions they could understand. No information as to their number, births and deaths, etc., could be obtained from the Philippine Government for the simple reason that they had none. The negrito has no unit of time, so knew nothing of his age; all ages therefore are approximate only.

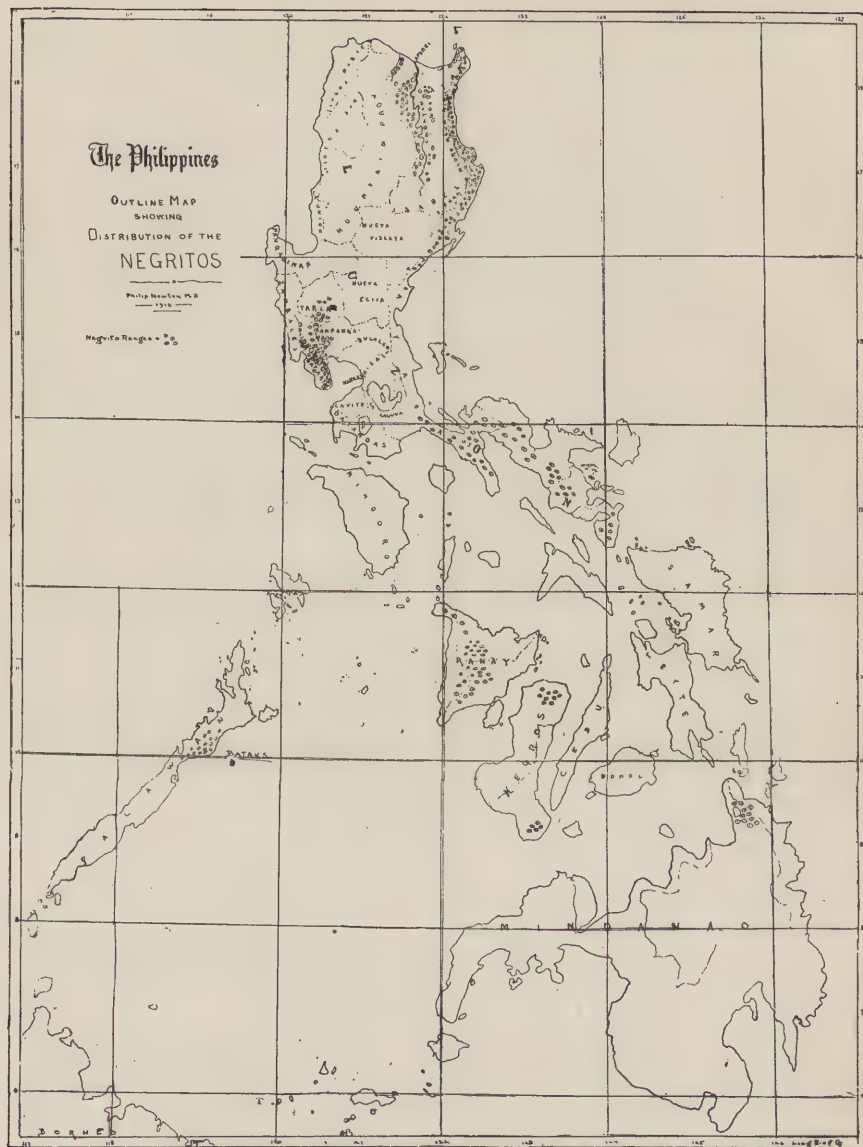
Expenses: The expenses of the trip were higher than expected. The bad weather greatly increased the cost of travel. The fear of the average Filipino for the negritos' poisoned arrows made guides and porters expensive. The deaths from surra, etc., of large numbers of horses and bulls made their use impossible in many places and very expensive in others.

General: Both wooden and metal instruments suffered from the effects of moisture. The wooden instruments, plate-holders, camera, etc., were all rendered partially unfit for service, and in the future all such articles should be made of some non-oxidizing metal, if they are to be used in the tropics.

Disease: The most common diseases in the Philippines, as observed by me, were malaria, dengue, dhobie's itch, and insect bites. At one time or another I personally experienced each one. I also suffered very much from an attack of maxillary sinusitis which was brought on by the constant exposure to rain and mud.

The accompanying report gives the results of my observations.

Very respectfully,
PHILIP NEWTON, M.D.



INTRODUCTION

During the months of June, July, August, and September, 1912, the writer visited the representative subdivisions of the Negritos in the Philippine Islands. The expedition was under the joint auspices of the Smithsonian Institution and the Pan-American Exposition of San Diego, and under the direction of Dr. A. Hrdlička. It was sent out for the purpose of making accurate anthropometric studies of the Negritos, and for making physiological and medical observations among them. The measurements and observations are those regularly used in the study of other races by the Division of Physical Anthropology of the United States National Museum; the methods of measurement were essentially those of the Inter-national Agreements.

The investigations were confined as nearly as possible to pure-bloods. The Bataks of Palawan, who are probably all of mixed blood, are placed in a separate series. Subjects showing gross pathological conditions were only noted in the medical observations.

The provinces visited were Bataan, Zambales, Pampanga, Tarlac, Cagayan, Isabela, and Palawan. Of these, Bataan was found to have more pure-bloods than any of the other localities. The Negritos of Zambales presented many signs of a more or less recent admixture of outside blood. The Negritos of Cagayan showed also a widespread admixture of foreign blood. Among the Negritos or Bataks of Palawan, hardly any were found who approached the pure-blood standard.

No objections to the measurements and observations were made by the Negritos after they understood the nature of the work. Owing, however, to the low order of intelligence exhibited in general by these people, various questions were not readily comprehended, so that some parts of the investigation became necessarily restricted. In addition, circumstances did not permit of an exhaustive study of certain physiological and pathological features of the Negrito life.

The pure-bloods, regardless of locality, were found to be physically of the same type, so that where uninfluenced by other races the Philippine Negrito differs only in language and some minor customs. The introduction of foreign blood rapidly changes these people both physically and mentally; and a contact with other tribes, produces readily marked changes in their habits.

GENERAL ENVIRONMENT

Distribution: The Negrito is found on the islands of Luzon, Negros, Mindanao, Palawan, Panay, Alabat, and Tablas. The greatest numbers live on Luzon.

This wide distribution, coupled with fact that the Negritos are not travelers (except on their own ranges), and that they do not possess physical qualities that might fit them for invaders, suggest that they were more numerous in these regions in the past and that they probably preceded the other aborigines of the Philippine Islands.

Much of the combined area of the Philippines is mountainous, and on those islands where the Negritos live, they are found, for the most part, in the highlands. Whether they were originally mountain people or not is unknown, but if they ever inhabited any of the lowlands, they have long since been crowded out. Quite likely the mountains represent their last stand, where they endeavor as much as possible to live by themselves. Those now found in the lowlands have evidently come there quite recently; they are as a rule dependents on some of the Philippino settlements.

Elevation: The elevation of the areas inhabited by the Negritos varies from 500 to 2,000 feet, or more. Their habitations are always found near mountain streams or small rivers. They prefer the wooded parts of the country where they are better secreted. Those not affected by outside influences stay in the mountains.

Climate: The climate of those parts of the Philippine Islands that are occupied by the Negrito is, notwithstanding the elevation, with the exception of the highest mountains, tropical. In the settlements of the northern half of the Archipelago rains and storms are almost continuous from June to September. From October to February the weather is generally cooler, with little rain. From March to June the weather where they live is hot and dry.

Water Supply: The sources of water of the Negritos comprise springs, mountain streams, and small rivers. They make no wells or reservoirs. The drying up of small streams during the hot season affects the Negritos but little, as they are continually moving about.

The water is carried from its source to the family shelter in bamboo poles three to seven feet long, from which all septa except the bottom one have been removed. Such a tube is easily carried, and will retain the water for several hours. Shorter pieces are used for drinking cups.

The water of the springs and smaller mountain streams is usually clear, but the larger streams and rivers were found muddy. In northern Luzon several hot springs were seen, the water of which was charged with mineral substances, including sulphur, and some of these are visited for curative purposes by the Filipinos, but no use is made of them by the Negritos.

Flora: The vegetation of the regions occupied by the Negrito is of much variety, but include only a few plants and trees which are made use of by these people. In several places visited by the writer the Negritos were seen to be used by the whites and Filipinos to help fell the trees and get them to the rivers, where they were floated to the mills. Bejuco, or rattan, is cut by the Negritos and used in making their shelters, as well as trade for cloth, knives, and alcoholic drinks. The bamboo is used in making the shelters, and for water vessels and arrows. Bananas, mangos, cocoanuts, and other kinds of tropical fruits, found in many localities, form, with certain edible roots, a large part of the Negrito diet. The Bataks use the bark of the "bago" tree for their breech-cloths. In one place the Negritos knew orchids had a commercial value, and frequently traded two varieties for articles of small cost. Hardly any use is made of plants medicinally by the Negrito.

Fauna: The animals of the forests are of importance to the Negritos because they furnish part of their diet. Small deer, wild hogs, wild birds, monkeys, lizards, and other small animals, are all killed and eaten. The methods of killing vary with the amount of outside influence that has affected the particular group of Negritos. In some regions (Bataan and Zambales) nets are used in the deer-hunt. The animals are driven into these and then killed with arrows; but in other regions the use of nets is unknown. In northern Luzon the Negritos use poisoned arrows. Analysis of the poison was impossible in the field, and little information could be obtained from either the Negritos or the Insular Government as to its nature. The symptoms exhibited by a deer when shot with such an arrow resemble those of strychnine poisoning, so that probably the substance is of the nature of curare.

Honey bees are abundant in some localities, and the Negritos gather considerable quantities of their product. The bees are smoked out, the wax and honey extracted in a mass and the honey strained through a soiled cloth into bamboo tubes.

Insects and Reptiles: In the forests where the Negritos live, mosqui-

toes are so numerous during the rainy season that white men visiting these regions must make a continuous fight against the pest. The mosquito bite, however, appears to cause a much lesser reaction in the Negrito than in the white. The Negrito's body, owing to the absence of clothing, offers a large area for mosquito attack, and there is little if any immunity to such attacks, but many bites seem to cause little irritation. A number of varieties of mosquitoes were observed, including the *Anopheles* and *Stegomyia*.

Fleas are very numerous. So are centipedes. The bite of the latter causes a sharp reaction, but apparently is never dangerous to life.

Snakes are not as numerous in the Negrito country as they are in other tropical lands, nevertheless a large number of varieties, some of which are poisonous, have been classified. Several cobras and other snakes were seen by the writer, but no recent deaths among the Negritos from snake bite could be learned of.

NEGRITO POPULATION

The last census of the Insular Government gives the total number of the Negritos at about 25,000. This number includes many thousands of mixed bloods. Just how many, no one knows. The writer's estimate of the total number of pure-bloods, outside of the unknown territory in northwestern Luzon, would be below 5,000. Accurate figures can scarcely be hoped for, for the reason that the Negritos are ordinarily located in wild, inaccessible regions, over which they are widely scattered in small groups. Nine Negrito districts, with a total estimated population of about 7,000, were visited by the writer.

Vital statistics concerning the Negrito, such as the death rate, birth rate, proportion of sexes, etc., were not obtainable from the Insular Government. Personal investigation of these subjects were carried on as far as circumstances permitted, but the possibilities were quite limited.

SUBDIVISIONS OF THE NEGRITOS

The Negritos, as known from previous writers,¹ are subdivided into a number of groups bearing distinct names, but these groups are so far

¹ Meyer, A. B. The distribution of the Negritos in the Philippine Islands and elsewhere. 8°, Dresden, 1899. Virchow, Rud. The peopling of the Philippines. An. Rep. Smithsonian Institution, Washington, 1899, 500-526. Reed, Wm. A. Negritos of Zambales. Ethnol. Survey Publ., Manila, 1904. II, Part I, 90 pp., 58 pl. Worcester, Dean C. The non-Christian tribes of northern Luzon. *Philippine J. of Sci.*, Vol. No. 8, Manila, Oct., 1906.

as could be ascertained purely geographical; physically, and in the pure-bloods no marked differences were observed in the different regions. Among the mixed-bloods, the differences depended upon the origin and proportion of the foreign blood. Variations in customs, habits, dress, and language appeared to be due largely to contact and environment.

The *Aetas* of Bataan, Zambales, Tarlac, and Pampanga, inhabit, in scattered bodies, the western mountain range (Zambales Mountains) of Luzon, from the Mariveles Mountain, in southern Luzon, as far north as the northern boundary of Tarlac province. A large percentage of the estimated 1,200 *Aetas* of the Bataan province are of a fairly pure type. They are found in small numbers at varying distances back of the Filipino towns of Mariveles, Bagao, Balanga, Orani, Hermosa, and others. The best types for study were those living farthest away from the Filipino towns, where outside influences were minimum. The foreign blood in the mixed types of Bataan appeared to be mostly Tagalog.

The *Aetas* of Zambales may be reached by traveling north or northwest from Hermosa, in Bataan, from Floridablanca, in Pampanga, or from Olongapo, Subig, and Iba, in Zambales. As in Bataan, the Negritos of this province living near Filipino towns showed considerably the results of outside influences. The percentage of mixed-bloods was considerably larger than in Bataan. The foreign blood appeared to be largely Tagalog and Ilokano.

The *Aetas* of the provinces of Pampanga and Tarlac in Luzon were not numerous, and a large percentage of them were plainly of the mixed-blood types. They may be reached by traveling west from Floridablanca in the province of Pampanga, and from Tarlac, in the province of Tarlac.

The *Attas* of Cagayan and Isabela provinces, in Luzon, inhabit the foothills and mountains between the Cagayan and Ablug Rivers, the mountains south of this area between the Kalinga region and the Cagayan River and, in small groups, the country between the Cagayan River and the Sierra Madre Mountains. Little information could be obtained about the western slope of the Sierra Madre. It is believed to be wholly inhabited by Negritos. If such is the case, this region would undoubtedly produce the most characteristic types of the people. In these two groups of Negritos foreign blood appears to have had several sources, including Kalinga, Cagayan, Ilokano, and Ilongot.

The *Bataks*, all of whom apparently are mixed-bloods, inhabit the mountains of the northern half of the island of Palawan. They were found in small groups by traveling inland from the coast towns of Babuyan, Tinabog, and Tinitian. The whole Batak population is estimated at less than 500 individuals. They differ from the pure-blood type of Negrito. Their skins are lighter, their hair is wavy or curly rather than woolly, the facial features are less negroid, and the average stature is greater. They resemble the Negrito in the excess of finger-reach over height, low foreheads, thick lips, and rather flat wide noses. Their average stature also, although superior to that of the pure-blood Negrito, is still below that of the neighboring tribes. Their foreign blood appears to have come largely from the Tagbanuas. Several individuals exhibited characteristic Chinese features.

PERSONAL ENVIRONMENT

Clothing: Negritos uninfluenced by other races dress very scantily; and the absence of sufficient clothing during the cooler months undoubtedly accounts among them for certain pathological conditions. The men wear a breechcloth only. This is a strip of cloth about six inches wide and four or five feet long. It is wrapped once around the waist, knotted loosely in the back, the two ends brought forward between the thighs and tied in front to the part around the waist. The women wear a short skirt which extends from the waist to a little above the knees. The skirt is a simple piece of cloth of variable width and about five or six feet long. * It is wrapped around the waist and hips and tucked in at the waist. The children go naked until about the sixth year, after which they dress like their parents.

On Negritos living near the Filipino towns, one can see odd garments of many kinds. They vary from the simple breechcloths to complete multicolored cotton suits with native hats. One of the first changes made by the Negrito women after coming into contact with a higher civilization is the adoption of the "camisa" or waist. With the adoption of this garment, the women assume a certain modesty about exposing their breasts. This delicacy was unknown among the Negritos living far off from Filipino villages, where the women went half nude and readily permitted the chest measurements and photographs to be taken.

Shoes, sandals, or other foot-coverings were not observed among the Negritos, even where mixed. Hats or other head-coverings were not used, except among those living in contact with civilization; the heavy, woolly, matted hair affording ample protection.

Hair-dressing and Other Practices: From a hygienic standpoint, the Negrito method of wearing the hair is very poor. The natural Negrito hair is very thick, black and woolly. It grows usually to a length of from two to five inches, and no attention is given it. As a result it becomes foul, matted, and more or less filled with vermin.

The Aetas of Bataan shave in a crude way, with a bolo, a circular area, about two inches in diameter, in the upper occipital region, which reminds one of the tonsura of the Spanish padres. This was observed in both sexes, and the reason for so doing was given as a means of "letting out the heat." The Bataks of Palawan shave the anterior half of the scalp, from a line connecting the external auditory meati. Both sexes are thus treated. No clear explanation of the custom could be obtained.

A very common custom observed among the Negritos in the province of Bataan (Luzon) was that of ornamental skin scarring. The operation is performed with sharp bamboo instruments, and begins about the sixth or eighth year. Both sexes are ornamented. Small incisions are made through the skin on the forearms, arms, back, and chest; in the female, also on the breasts, abdomen, and thighs. The most common design is that of a series of short parallel lines, converging to a point with another series; or the two series may be parallel. Less common is a design of five short incisions in the form of a star. Several operations are performed in the case of large ornamentations. The wounds commonly become infected and heal with the formation of an elevated, light-colored scar.

The above custom was observed only in Bataan. In addition, the Negritos of Bataan, in common with those of Zambales, exhibited irregular scars of other origin on their arms and forearms. These scars resulted from burns made by holding embers against the skin. Two explanations of this custom were given: First, it was a means of curing in febrile diseases; and second, it was used as a test of bravery.

A widespread custom among the Negrito women is that of perforating the lobule of the lobe of the ear. This serves for the reception of flowers. It was observed in practically every region visited by the writer. It is made at the seventh or eighth year with a sharp bamboo stick. In young girls it is quite small, but owing to the repeated introduction of flowers, it becomes by the time adult life is reached very large. Flowers are the only ornaments used by the full-blood Negritos.

Dwellings: These vary from the shelter of a large tree to a crude imitation of the nipa house of the Filipino. The commonest form is

very simple. It is easily constructed and as easily abandoned. Two poles about seven feet long are cut and inserted into the ground in holes dug with a bolo, about five feet apart. A ridge pole is then tied to the uprights. On this ridge-pole is balanced a framework filled in beforehand with woven grass. Between the poles and about one and one half feet from the ground is made on short bamboo posts a crude seat or bed; and that is all, except that the top of the hut is adjusted from time to time during the day to meet the change in the sun's rays.

More substantial shelters are constructed by the Negritos living near other tribes. The best of them, however, afford little protection against the elements. The only thing that can be said in their favor is that they are well ventilated.

Individual shelters are isolated. Groups of from twenty to seventy Negritos, banded together by family or other ties, will construct their shelters at distances varying from two hundred to eight hundred yards from each other. Within a few square miles there may be found several such groups. The different groups are friendly, and there are frequent inter-marriages.

Within the Negrito shelter there is no furniture other than the crude bamboo floor or bed. Grass may be spread on this, but there are no blankets. Cooking is done over crudely constructed fireplaces outside of the shelter.

Sanitation: Personal necessities are attended to in any convenient spot near the dwelling. During the rainy season the refuse is washed away almost immediately, but during the dry season the decomposing material attracts thousands of flies and other insects, and the growing bad odor causes the inhabitants to make frequent changes of residence.

If a Negrito develops a contagious disease, such as smallpox, and it is recognized, food and drink are placed near the patient in the shelter and the rest of the family desert him. After a few days someone returns, and if the patient is still alive, more food and drink are placed by his side. This practice is continued until he recovers or dies.

The dead are buried under or near the shelter they have occupied during life, and the rest of the family move to a new location. Among the Negritos unaffected by civilization, the body is placed, without covering or coffin, in a shallow grave, and covered over with dirt. No ceremonies so far as could be learned are observed. Due to the climate the body, including the osseous structures, undergoes a very rapid decay.

Personal Hygiene: The scanty clothes of the Negritos are apparently never washed. Bathing of the body is a very infrequent occurrence. The teeth are never cleaned. Among a few groups the custom of pointing the incisor teeth was observed. It is more common on the males than in the females. It is practiced during advanced adolescence; the youngest subject seen with teeth mutilated in this manner was a girl about fifteen years old. A small block is placed against inner surface of the tooth, and the point of the bolo brought sharply against the outer surface. Decay sets in rapidly in these mutilated teeth, other teeth decay also quite readily and after forty years of age the average Negrito has usually a poor denture. The ears and noses of the Negritos of all ages, besides the hair, as mentioned before, are generally likewise very dirty.

Experience appears to have taught these people little about taking care of themselves. Year after year exposure during the cold foggy nights of certain seasons induces pulmonary diseases from which many children die. They readily point this condition out as being one of the main causes of death among children, but do nothing at all to improve matters at the next favorable season.

Occupations: Strictly speaking, the Negrito uninfluenced by contact has no occupation other than hunting game and gathering wild fruit and roots for his subsistence. The men construct shelters, and make their bows and arrows. As for agricultural work, little is done by the average Negrito. Small areas are cleared and planted with rice by those Negritos who have watched other tribes raise crops, but just as frequently as not the family is said to move away from the growing rice before it is ripe, without returning for the harvest.

Among Negritos living near the more civilized Filipinos (Tagalogs, Ilokanos, etc.), occupations of a more useful kind are observed, such as farming, lumbering, gathering gums and rattan, portering, and acting as household servants for other races. But this intimacy with semi-civilization does not improve the Negrito either socially or hygienically. He soon acquires a craving for alcohol, while his brother of the far-off mountain regions knows nothing of such beverages. He seldom acquires an understanding of the value of his services or of money, as a consequence of which he is much imposed upon. It is not unusual to see petty officials of the Filipino villages getting rich at the expense of the ignorant Negritos.

Small Negrito boys were many times seen acting as house-boys for other races. Inquiry elicited the fact that these boys almost in-

variably returned to their natural life shortly after reaching the age of puberty, and that attempts to educate them had failed. However, mixed-breed Negrito children are more amenable to the restraints of civilization.

Food: The principal articles of diet among the wild Negritos, in the main as already indicated, are fruit, edible roots, and the meat of wild animals. The animals are small deer, wild hogs, lizards, monkeys, birds and wild chickens. Honey is sought for and eaten with relish. The vegetable products of the forests include bananas, mangos, cocoanuts, berries, wild camote, and the roots of a few other plants. Rice and fish are eaten when obtainable. Negritos are not fishermen, but they shoot fish in the mountain streams with their arrows, when they see them.

The preparation of food is primitive. Meat is usually roasted over a crude fireplace. If a utensil for the purpose is at hand, the meat may be boiled with fruit, rice, or other vegetables.

If food is plentiful, the Negrito will have three or four meals a day. If it is scarce, only one meal a day may be eaten.

The hours for meals among the wilder groups are very irregular. There is no set time for any one meal during the day. If food is plentiful, as is the case after a deer has been killed, the quantity of food consumed at the next meal will be greater than is ordinarily the case. Under ordinary circumstances the largest meal is eaten during the afternoon, usually an hour or two before sunset.

Alcohol and Drug Habits: No alcoholic drinks are manufactured by the wild Negritos and their use is unknown. Those living near villages of other tribes become readily intoxicated. Many will work harder if rewarded with drink than if paid with money.

The chewing of betel nuts (the seeds of a palm, *Areca catechu*) is an almost universal practice among the Negritos. Even those groups living far off from other tribes have this habit, which, however, is not confined to the Negritos. The Negritos living far off acquire the betel nuts by trade with those living nearer trading centers. The Negritos of two regions in the north of Luzon did not use the nut and, as far as the writer could ascertain, did not know of its existence. The physiological effects of the betel-nut chewing habit are not well determined.

Smoking is indulged in by men, women, and children when tobacco is available. No tobacco, however, is raised by the Negritos, and its use is very limited in the wilder regions.

GENERAL HABITS OF LIFE, CHARACTER, AND SOCIAL CONDITION.

Negritos usually sleep from darkness to dawn. If they are on the march, they sleep wherever darkness overtakes them. Even in the rainy season they will sleep with a tree as their only protection against the elements.

Upon arising the Negrito gives no thought to personal cleanliness. When a Negrito enters water it is usually as a means of crossing the stream, or for a relief from the heat.

The average Negrito is not industrious, unless it be in the quest for much needed food or in the hunt. Under proper guidance, he will work, but never very strenuously or for a long time. He may be made to build a comparatively large bamboo and grass house for others, but remains perfectly satisfied with a small flimsy shelter for himself and his family.

As to amusements, dancing and playing primitive games are common among the children and younger adults. Gambling was not observed anywhere.

In disposition, the Negritos are cheerful and contented. Their wants are few, and their passions moderate.

The moral status of the Negritos living far away from other tribes is good; among the mixed breeds however and with the Negritos living in or around villages of other tribes, it is of low standard.

Social Abnormalities. Artificial Abortion: Desire for and love of young children were strong among the Negritos. Artificial abortion was not reported. Accidents causing abortion were reported in three cases.

Infanticide: This was unknown.

Crime: The Negritos of Bataan were reported to be a very peaceful people. In the North, certain groups are in almost continuous war with the Kalingas. Murder and assault are very infrequent among the unaffected groups, and when they occur they are usually tribal punishment rather than individual differences. Incentive to theft and robbery are wanting among the Negritos because of the absence of articles of value.

Suicide: No suicides were reported among the groups visited.

REPRODUCTION

Marriage: Marriage among both the pure-blood types and the breeds is entered into at an early age. Some degree of mutual attraction is

said to usually exist before the union. Voluntary loss of chastity on the part of the unmarried woman was reported as quite infrequent; but if it occurs it is not regarded as a serious obstacle to future marriage. The girl usually exercises the right of acceptance. Among the pure types separation is said to be rather rare. Polyandry was seen in two instances among the Bataks. Polygamy was observed several times during the trip among the mixed types, the man in each case being of enough importance to support two wives.

Intermarriage of relatives nearer than first cousins was not learned of.

The approximate age of several girls just married, or about to be married, was between fourteen and sixteen. The approximate age of puberty is seemingly about twelve.

Sterile Women; Preference of Sex; Gestation. In the series given above, there were ten couples to whom children had not been born two or more years after marriage. Further information along these lines is lacking for the reason that the Negritos did not comprehend the questions.

Most of the women questioned appeared to want boys more than girls.

Pregnancy does not interfere materially with the daily life of the Negrito women. Even in the last months of gestation these women travel with the rest of the family. No special precautions, such as special diets, avoidance of work, etc., were observed. Morning sickness was unknown.

Labor: Preparation for childbirth does not occur. When the first pains come on the woman seeks her dwelling or the shelter of a tree. In the intervals between pains she may walk around a few steps, but during the pains she remains lying on the ground. Delivery usually occurs in the kneeling or squatting position. In the larger groups, older women act as assistants. If the family is on the march, another woman and the husband, or the husband alone, assist. In any event, the assistance rendered is very little. The assistant simply catches the child when it is born, and holds it while the mother assumes the dorsal recumbent posture. After a few minutes the cord is tied with a piece of vegetable fiber about three or four inches from the umbilicus, and the cord severed beyond this. A bolo is used in most cases to cut the cord with. Delivery of the placenta follows in a few minutes, the average time for the few cases seen being less than in civilized races.

After delivery the woman remains quiet for three or four hours, but travel is not resumed until the second or third day. No cleansing of either the mother or child is attempted. Fresh green leaves are placed on the stump of the cord, and the child placed to the mother's breast. If a piece of cloth is at hand, the child is wrapped in it, but in many instances the only protection against exposure is the mother's body.

Some dystocia was reported in a few instances, but it appears to be rare. One case of what was apparently a transverse presentation was spoken of; the mother and child both perished. A few deaths during the puerperium were mentioned, but ordinarily this period is declared to be free from disease. No change is made in the diet. Twins were not seen, and only reported three times. Histories of triplets or monstrosities were not obtained. Minor abnormalities were reported in a few cases.

Early Attention to the Infant. Nursing and Feeding: No apparatus of any kind is used to carry the infant in. The child as mentioned is placed on the mother's breast immediately after the cord is cut, and remains constantly with the mother until it learns to walk. The flow of milk is usually established promptly, and the child nurses at the breast for twelve or fourteen months. About the sixth month and after the child is given small bits of any kind of food the parents happen to secure for their own subsistence. Clothing for the child is ordinarily restricted to one piece of cloth which is wrapped around the trunk, but in many cases even this slight protection is wanting, and the child goes naked until it is given a breechcloth or a small skirt.

VITAL STATISTICS

The foregoing paragraphs have touched on the ordinary conditions of life and such of the characteristics of the Negritos of the Philippine Islands as are presumably capable of influencing their physiological functions and health.

The environment in which the Negrito originally developed is naturally unknown. Their present environment can hardly be assumed to be their natural one, judging by the traces of their widespread distribution, their more or less rapid absorption by other races, and especially by one important physiological difference between them and other races having an analogous environment. This difference in function is that of the small number of children actually born to each family, and the long intervals between births.

From the table given below, it will be seen that ninety-three families

had a total of two hundred and eleven children born to them, an average of 2.27 children per family. These families were all of the pure-blood type, and represented widely separated groups of Negritos. No practice of any kind for the prevention of conception could be learned of, nor would the number of abortions and miscarriages account for this restricted number of births.

Nursing at the breast is not unduly prolonged, the child being given the regular family diet after the twelfth or fourteenth month, and some of it, of course, much sooner.

FAMILY STATISTICS
(93¹ NEGRITO FAMILIES)

Subjects Investigated	Total	Percentage of Total Born	Percentage of Number of Living and Dead	Ratio of Males and Females (Females=100)
Total births.....	211	.....	.....	.....
Boys.....	106	50.23	.....	.....
Girls.....	105	49.76	.....	100.95
Total surviving.....	118	55.92	.....	.....
Boys.....	60	56.60	50.85	103.44
Girls.....	58	55.23	49.15	.....
Total died.....	93	44.07	.....	.....
Boys.....	46	43.39	49.46	97.87
Girls.....	47	44.77	50.54	.....

Population by Ages: No figures can be given for this interesting subject. Ages in all cases had to be approximated, as the Negritos know nothing of reckoning time. It was observed by approximation, however, that the number of individuals reaching old age (65 years or over) was remarkably small. Environment accounts for this mortality beyond a doubt. In those individuals approximated to be over forty-five years of age the teeth were, as already mentioned, almost invariably decayed to such an extent that mastication was seriously impaired, and poor mastication leads to malnutrition if continued over a period of years, thus lowering the resistance of the subject to pathogenic influences. With his lowered vitality the subject becomes an easy victim to bronchial or lung disease caused by exposure to the cold damp nights of certain seasons of the year.

The mortality for all ages of children was 44 per cent. When compared with the mortality among the children in the provincial Filipino

¹ Ten of these families had no children born to them, although living together in each case for two years or more.

villages, it will be found that the death rate is smaller among the Negritos than among the Filipinos.

Size of Families: The writer's figures given above in the table of children born to ninety-three families are the only ones available. From this limited investigation, it will be seen that the number of living children for ninety-three families was 118, or 1.26 children per family. The greatest number of children born to families of the pure-blood type was five, and the greatest number of living children in one family was three. Among the mixed types, the percentage of children born was greater, as many as nine being reported in each of two families.

It is quite apparent from this that the birth rate among the pure-blood types is insufficient to keep up the numerical strength of the people.

Proportion of Sexes: Nothing reliable is known about the proportion of sexes. More men than women were seen, as the men are greater travelers. Figures are not available for large numbers, but personal observation indicated that there was no undue proportion of one sex over the other.

PHYSIOLOGICAL OBSERVATIONS

The details of these observations, as well as those of the anthropometric measurements, must be reserved for a future publication.

Pulse, Respiration, Temperature: The pulse was found to be somewhat more frequent in the Negritos than it is in average whites, the mean in one hundred healthy Negrito men being 76.1, in fifty healthy women 76.3 per minute. This in sitting position and with the individual at rest. The normal in whites is, as well known, about 71 in men and slightly more in women. Respiration, under same conditions, averaged 18.05 in the males and 18.3 per minute in the females; temperature (sub lingua), slightly less than 98.6 in the males and slightly more than 98.6 in the females. Among healthy white Americans examined in the same way Dr. Hrdlička obtains the averages, for respiration, of 17 in men and 18.4 in women, for temperature 98.5 in men and 98.7 in women. The Negritos may thus be said to present a perceptibly more rapid pulse than the whites; a slightly more frequent respiration in the males; and practically the same temperature. Their lack of clothing favors of course heat radiation, though this may be offset more or less through adaptive changes in the skin.

A number of interesting observations were made in connection with these tests. Four young pregnant women gave the pulse of 96, 86, 90, 92; respiration of 20, 22, 23, and 26; and temperatures of 98.8, 98.7, 98.6, and 98.8. The pulse considerably increased with the respiration moderately so, but temperature quite normal. Fatigued persons, on the other hand, and those hungry, gave invariably lower pulse, respiration as well as temperature. In a group of eighteen males the temperature, taken between five and six o'clock in the morning, was found in each case to be from one to two and a half degrees below normal. Inquiry developed the fact that the men had been marching all night, and had no food for twelve hours. The temperature was taken again about one hour after a meal and in each case was found to be about the average. Slight lowering of pulse, respiration as well as temperature was also noticed in the older persons.

The averages, minima and maxima of the above determinations, in healthy persons, were as follows:

	Males			Females		
	Average	Minimum	Maximum	Average	Minimum	Maximum
Pulse.....	76.1	64	88	76.3	66	84
Respiration.....	18.05	16	20	18.3	16	20
Temperature.....	98.58	97.8	99.2	98.62	98.2	99.6

Muscular Force: This was determined by obtaining the maximum pressure in each hand with a standard Collin dynamometer. The averages for both sexes was considerably lower than the averages for the white race.

The Skin and Its Appendages: The color of the skin in adult Negritos of the pure-blood type was uniformly chocolate brown. Numerous comparisons with Broca's Color Standards showed it to correspond most closely with Nos. 42 and 43. The mucous membranes were hemoglobin red with a bluish tinge. The hair on all parts of the body where it grew was black, with an occasional discoloration due to exposure to the sun. Irregularities of pigmentation were frequent. They were due almost entirely to tinea imbricata, except in Bataan, where the practice of ornamental scarring was observed. The skin was ordinarily dirty and unhealthy. Sweating was not more profuse than would be expected in a tropical country.

The hair on the head was from two to six inches in length. It was uniformly black, coarse, and woolly. The beard and mustache were generally scant and short. Baldness was observed in the oldest

individuals, but was never pronounced. Grayness was common, but nothing can be said regarding the actual age of its appearance.

ANTHROPOMETRY

Measurements and special somatic as well as physiological observations were made on 147 full-blood adult men and fifty women, as well as on a series of mixed bloods. The elaboration of this material was interrupted by the war and the final report on the numerous interesting results must therefore be delayed. A brief abstract of the measurements of the stature and of those of the head is however appended.

STATURE AND HEAD MEASUREMENT OF THE NEGRITOS (FULL-BLOODS)

MALES (147 adults)

FEMALES (50 adults)

	Average, Cm.	Minimum, Cm.	Maximum, Cm.	Average, Cm.	Minimum, Cm.	Maximum, Cm.
Stature.....	147. —	140.2	— 154.3	138. —	129.6	— 146.1
Head:						
Length max.....	18. —	17. —	— 18.8	17.4	16.1	— 18.4
Breadth max.....	14.9	13.9	— 15.6	14.5	13.6	— 15.6
Height ¹	12.4	11.6	— 13.1	12.4	11.5	— 12.7
Indices:						
Cephalic.....		82.7			83.5	
Height-Length.....		68.9			71.4	
Height-Breadth.....		83.3			85.5	
Height-Index ²		75.4			77.8	
Face:						
(a) Height menton- nasion.....	10. —	8.9	— 11. —	9.4	8.4	— 10.4
(b) Height menton- crinion.....	17.3	15.5	— 18.7	16.1	14.3	— 17.3
(c) Diam. bizygo- matic max.	13.55	12.4	14.2	13. —	12.1	14. —
Facial Index, lower $\frac{a \times 100}{c}$		74.			72.5	
Facial Index, total $\frac{c \times 100}{b}$		78.3			80.6	

MEDICAL OBSERVATIONS

Many agencies capable of affecting the Negrito's health have been mentioned in the preceding paragraphs.

Mosquitoes are the most troublesome insects. Their bite does not cause a severe reaction in the Negrito, but during certain seasons these

¹ From line connecting the floor of meatus auditor to bregina.

² Height multiplied by 100, divided by the mean of length and breadth.

insects cause enough irritation to seriously interfere with sleep. Centipedes, fleas, ants, and several species of mites are all the cause of much local irritation. Investigation as to snake-bites revealed nothing among the Negritos, although death from snake-bite was common among the Filipinos.

The dry season is naturally the more healthful one. During the rainy season malaria and bronchial diseases are common, the latter causing many deaths among the very young and the aged. Gastro-intestinal diseases are more prevalent during the wet seasons, owing apparently to contamination of the water supply.

DISEASES

Diseases of the Skin: Tinea Imbricata, a form of body ringworm produced by a trichophyton, and characterized by a concentric arrangement of closely set rings of scaling epidermis, is very widespread among the Negritos. It was observed in all stages of severity, from a few spots to an involvement of the entire surface of the body, with the exception of the palms and soles and the scalp. The disease is communicated by contact, and fostered by uncleanness. *Acne vulgaris* was common at the age of puberty and adolescence. *Pediculosis capitis* and *corpus* were quite common, especially head lice. *Tropical itches* of several varieties were observed. *Keloid* was seen in two cases. *Boils* were seen several times.

General Diseases: Malaria was very widespread among many groups, and less frequent among a few groups far off from other habitations. No blood examinations were made, but from the clinical findings diagnoses of both the benign and the malignant forms were made. The methods of treatment were very primitive and quite ineffectual. The application of hot embers to the naked skin, for the purpose of "drawing out the fever," was frequently tried among certain groups in Bataan and Zambales. Among other groups the "medicine" woman attempted, by means of much vocal noise and many bodily contortions, to draw the fever from the body of the patient to her own body.

Deaths from the malignant form of malaria (æstivo-autumnal infection) were reported a number of times. In the benign forms, the disease usually runs its course, to reappear the next year. No reliable statistics were obtained as to the percentage of the Negrito population that suffered from malaria, but during the season of rains when the writer made his studies, the disease was quite prevalent among both sexes and all ages. Judging from the number of mos-

quitoes which included a large percentage of the *Anopheles* group, the chances for infection were very large. The patients were in no way protected, thus allowing many more mosquitoes to become infected. Quinine was unknown, except to a small group of Negritos who visited the St. Louis Exposition in 1904. Whenever it was possible to do so, the malaria patients were dosed with quinine; frequent moves did not permit of an exhausted study of the results of the treatment, but in many cases the drug had a prompt and beneficial effect.

Tuberculosis: This disease was diagnosed but twice among the pure-blood type. Both cases were of the pulmonary form, and both presented the characteristic physical signs. One case was a female, approximately twenty years of age, the other a male, approximately twenty-five years of age. Both cases gave histories of contact with Filipinos, among whom the disease is very common. With these exceptions, tuberculosis was not observed. Considering the open-air life of the Negrito, this is as would be anticipated.

Leprosy: No case of leprosy among the Negritos was seen, even at the Leper Colony, where more than two thousand lepers were segregated. Inquiries indicated that leprosy was unknown in these people.

Variola: About ten per cent of the total number of Negritos examined showed the characteristic scars resulting from smallpox. The disease itself was not seen, and information gathered from various sources showed that smallpox had not been epidemic for over four years. In all cases, the infection was at first communicated to those Negritos living near the Filipino towns, and from them to the Negritos living farther away. Systematic vaccination among the more civilized tribes resulted in checking the ravages among them, and secondarily among the Negritos, by removing the source of infection.

Dengue: This disease was observed among a few mixed-breeds living near Filipino villages.

Gastro-intestinal Diseases. Dysentery: This disease existed in about fifteen per cent of the Negritos. Lack of time and apparatus precluded more than a cursory examination, and it is likely that many of the diarrhoeal conditions were not true dysentery. The insanitary surroundings and water contaminations already referred to presented numerous opportunities for infection.

Typhoid fever and cholera: These two diseases were not seen, and histories as to their occurrence were negative.

Diarrhoeal diseases of children: Indiscriminate feeding of young children resulted in many cases of intestinal disorder. Notwith-

standing this peculiar diet, the Negrito child was stronger than the average white child of the same age. Green fruit and exposure were causes of intestinal disorders in the older children.

Diseases of the Respiratory Tract. *Acute coryza*: "Catching cold" was more frequent among the children than among the adults. *Bronchitis*: During the cold, damp nights of certain seasons acute bronchitis is reported as common among the children and the aged. This disease and pneumonia (lobar) were actually diagnosed in more than thirty patients. The writer was told repeatedly that bronchial diseases were the cause of death among children in most cases.

Venereal Diseases. *Syphilis*: Manifestations of this disease were not seen in any individual of the pure-blood type. Contact with other races was accountable for its presence in a few mixed-breeds. *Gonorrhœa*: No evidences of this disease were seen. No special examination was made, but the absence of ophthalmia and blindness were taken as indicators.

Surgical Conditions. *Fractures*: Fractures in long bones are treated by rest, the most common result being deformity. *Wounds*: The only treatment observed was the application of green leaves to the wound. Infections usually occurred, with healing by second intention and the formation of a scar.

Cutting Operations: The only operations observed have already been mentioned, *i.e.*, the incisions made for the purpose of ornamental scarring, the perforation of the external ears in females, and the cutting of the umbilical cord.

Anomalies and Deformities: Six fingers on one hand were seen in one case. The subject was a young adult male. Congenital absence of the small toe was seen in a male child about twelve years of age. *Deformities* resulting from fractures have been mentioned. The rachitic deformities so common in the negro race in the United States were not once seen. Spread-toes was a universal condition. In this condition the great toe deviates somewhat towards the median line, and is well developed from constant climbing. The foot of the new-born child is quite normal.

CRITICAL CONSIDERATIONS

Racial comparisons and critical considerations of the data obtained on the Negrito through the study of which the above is a partial report, must be postponed until the detailed results of the measurements and observations can be published. This special ethnic group is however of such interest that even the preliminary remarks here given may be of service.

THE INDIAN BRAIN

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The three Indian brains which are the basis of this study are from the great brain collection of the Division of Physical Anthropology in the United States National Museum, and were called to the writer's attention by Dr. Aleš Hrdlička, Curator of the Division, who was also instrumental in arranging their loan. They consist of two full-blood Tonto Apache, collected many years ago by Dr. Washington Mathews, and one full-blood Teton Sioux, collected by Hrdlička. With the brain of an Omaha Indian recently reported from the University of Nebraska Medical College¹ and a specimen in Johns Hopkins, they are the only brains from this race that have been preserved in this country. And as the difficulty of obtaining full-blood North American Indian brains for study increases, due to the extensive admixture with other races, it is important that this material be placed upon record.

Although the interpretation of cerebral characters has not yet furnished a certain guide to the establishment of mental differences of race, sex or individual, the knowledge of the evolution, structure and function of the cerebral cortex has advanced sufficiently in the last ten years to permit a better comparison of cerebra than was possible at the time of the great monographs of Eberstaller,² Cunningham³ and Retzius.⁴ The significance of this later work of functional and histological localization in the establishment of definite relations between areas of cortex and the fissural pattern has not been emphasized by many writers in cerebral anthropology, perhaps due to the still rather incomplete knowledge in the subject and the uncertainty of its application. But that it has proven of distinct value, furnishes the most rational interpretation of fissures and convolutions and offers the most promise in future investigations, I hope to show by a brief review

¹ Keegan, J. J., A plains Indian brain.—*J. Comp. Neurol.*, 1916, xxvi, 403.

² Das Stirnhirn, 1890.

³ Surface anatomy of the cerebral hemispheres.—*Mem. Roy. Irish Acad.*, 1892, No. 7.

⁴ Das Menschenhirn, 1896.

of the more specific literature and an application to the material which is the subject of this paper.

The first conception of the brain as the seat of the mind dates back to 500 B.C. but even as recently as 1800 it was common among the best authorities to attribute a number of the emotions and passions to visceral organs as the heart, the stomach, the liver, etc., or to consider the seat of the soul to be localized in the fluid of the cerebral ventricles, an idea which had descended from Herophilus and Galen.¹ These irrational ideas at such a late period, when even a considerable knowledge of the detailed anatomy of the brain existed, were due largely to the insensitiveness of the cerebral cortex when exposed and the lack of response to mechanical stimulation.

The emphasis upon the gray matter of the cerebral cortex as the seat of all mental activities was first advanced by Gall and Spurzheim² about a hundred years ago in an elaborate theory or system of cerebral localization. Their conception of the brain as the basis of all mental activity was not controlled by the scientific evidence at hand, but was elaborated by fantastic ideas into a system of subdivision of all regions of the cerebral cortex into localized areas, each of which represented some prominent mental faculty or moral characteristic. This system, popularly known as phrenology and existing to-day as a cult of fortune-telling, obtained many followers for a time even among scientific men, but was soon supposedly proven to be fallacious by physiological experimentation on lower animals, and extirpations or destruction of small and large parts of the cerebral hemispheres without any apparent loss of specific functions but rather a diminution of all functions, thus showing the brain to act as a unit or whole and not as separate localized parts or areas. Following this criticism the wave of scientific opinion went to the other extreme and with difficulty entertained any idea of localization of function in the cerebral cortex. But the gradual accumulation of physiological and clinical evidence of a cerebral localization, especially the establishment by Broca in 1861 of a localized motor speech center in the inferior frontal gyrus of the left hemisphere, began again to arouse suspicions that there is a type of localization in the cerebral cortex, but related rather to different motor and sensory functions than to higher mental faculties.

This renewed interest in the cerebral cortex from the standpoint of functional localization demanded experimental evidence and better

¹ Soury, J., *Le système nerveux central*, 1899.

² *Anatomie et physiologie du système nerveux*, 1810-12.

definition. This was begun by the work of Fritsch and Hitzig¹ who, contrary to the previous claims of the non-excitability of the cerebral cortex, obtained definite and fixed motor response from galvanic electric current stimulation in the region of the sulcus cruciatus of the dog's cortex. These experiments were extended and presented in greater detail by Ferrier² on the dog and lower apes by use of the faradic electric current instead of the galvanic, which elicits greater response and is less depressing to the irritability of the cortex. This first work on the ape established the constancy and homology of the sulcus centralis in its relation to the motor excitable cortex. Beevor and Horsley³ in a similar series of experiments upon the lower apes subdivided this motor region of cortex into constant areas, each connected with definite movements in some part of the body, locating these on both sides of the sulcus centralis and attributing overlapping qualities to them. In later work upon the higher apes they claimed these areas to be more definitely localized, with intervening portions of non-excitability cortex. Grünbaum and Sherrington⁴ advanced still further the exact localization of the limits of the motor cortex from experiments upon the highest apes, the orang, gorilla and chimpanzee. They found in each of the animals examined that the same order of motor areas was present, with overlapping qualities however, within the precentral convolution and limited rather sharply posteriorly by the floor of the sulcus centralis. Added to these experiments on the ape brain were a few observations from stimulation of this region of the exposed human cerebral cortex, which practically agreed with the findings in the higher apes in the location and the motor areas.

This experimental work, however, was limited to the motor cortex as the only excitable portion, with a rapidly decreasing proportionate size from the lower apes to man. The proof of a limited cortical localization of function suggested the possibility of a more general cortical localization. This was supported by numerous clinical observations of specific sensory or psychic defects from localized injury or tumor, the most striking being the long recognized speech or language defects, the loss of power of articulate or written language and loss of auditory or visual memory of language, each existing

¹ Elektrische Erregbarkeit des Grosshirns.—*Arch. f. Anat. Physiol. u. Wissen. Med.*, 1870.

² Functions of the brain, 1876.

³ *Phil. Trans.*, 1890.

⁴ Physiology of the cerebral cortex of the anthropoid apes.—*Proc. Roy. Soc.*, 1903, lxxii, 109.

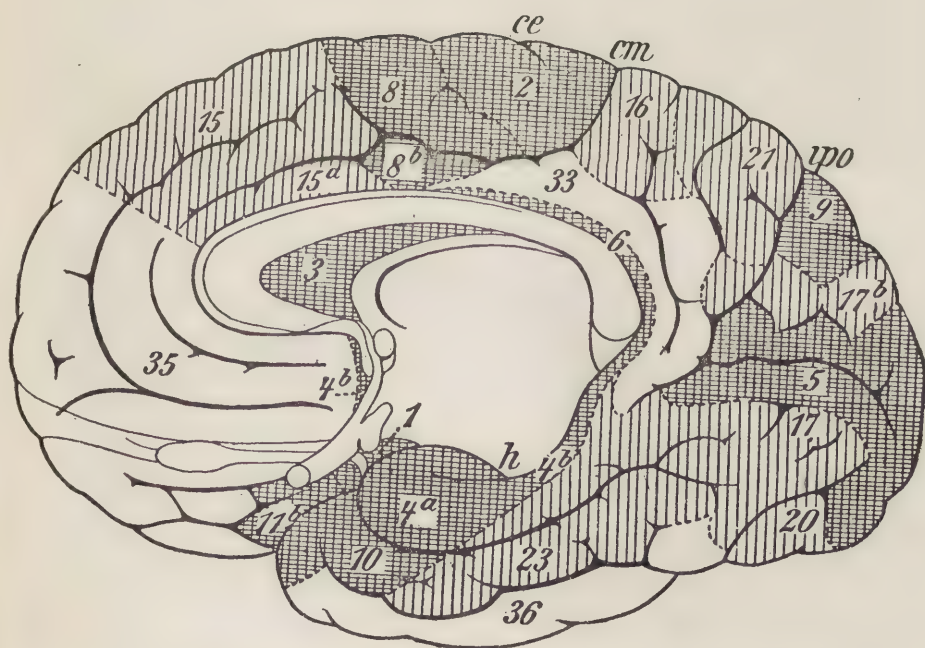
separately and associated with lesions in a certain region of the cortex. But the difficulty of an exact functional localization, except in the motor region, and the apparently undefined irregularities of the fissures and convolutions, stimulated a search for an internal structural basis for differentiation of cortical areas. Evidence of such a general structural localization was first advanced by Flechsig,¹ although the association of the Betz cell area with the motor cortex and the area striata with the visual cortex had long been recognized. Flechsig found that the myelin sheath of the nerve fibers of the cerebral cortex does not develop everywhere simultaneously or to the same degree, but by areas and in a definite order of succession. He claimed that thus there come into existence sharply circumscribed areas differing in the stages of development of their elements; that these fields are constant in their arrangement and repeat themselves in essentially the same position and extent in all individuals of approximately the same age. The number of such localized areas was first placed at forty but later reduced to thirty-six² (Plate I). Flechsig interpreted that since every area possessed a special anatomical position it also possessed a special functional significance, which for a few of the areas had been proven by experimental and clinical evidence. In a more general way he divided the entire cortex into three regions or zones: primordial zones which myelinate before birth, mainly primary sensory and motor; intermediate which are myelinated in the first month after birth, psycho-sensory or psycho-motor; and terminal zones which are myelinated in the second month after birth, the so-called higher association centers which represent the latest development of the central nervous system and are the most characteristic feature of the higher development of the human brain.

The next step towards the proof of a general structural localization in the cerebral cortex, and inferred functional localization, was a complete histological examination of the adult cortex in search for regional differentiation and definite boundary lines of transition from one area to another. This was first completed by Campbell³ in a very important monograph based upon a combined study of fiber disposition and of cell lamination in the entire cerebral cortex of man, ape, dog, cat and pig. On the basis of structural differentiation and functional interpretation he succeeded in mapping out about fifteen

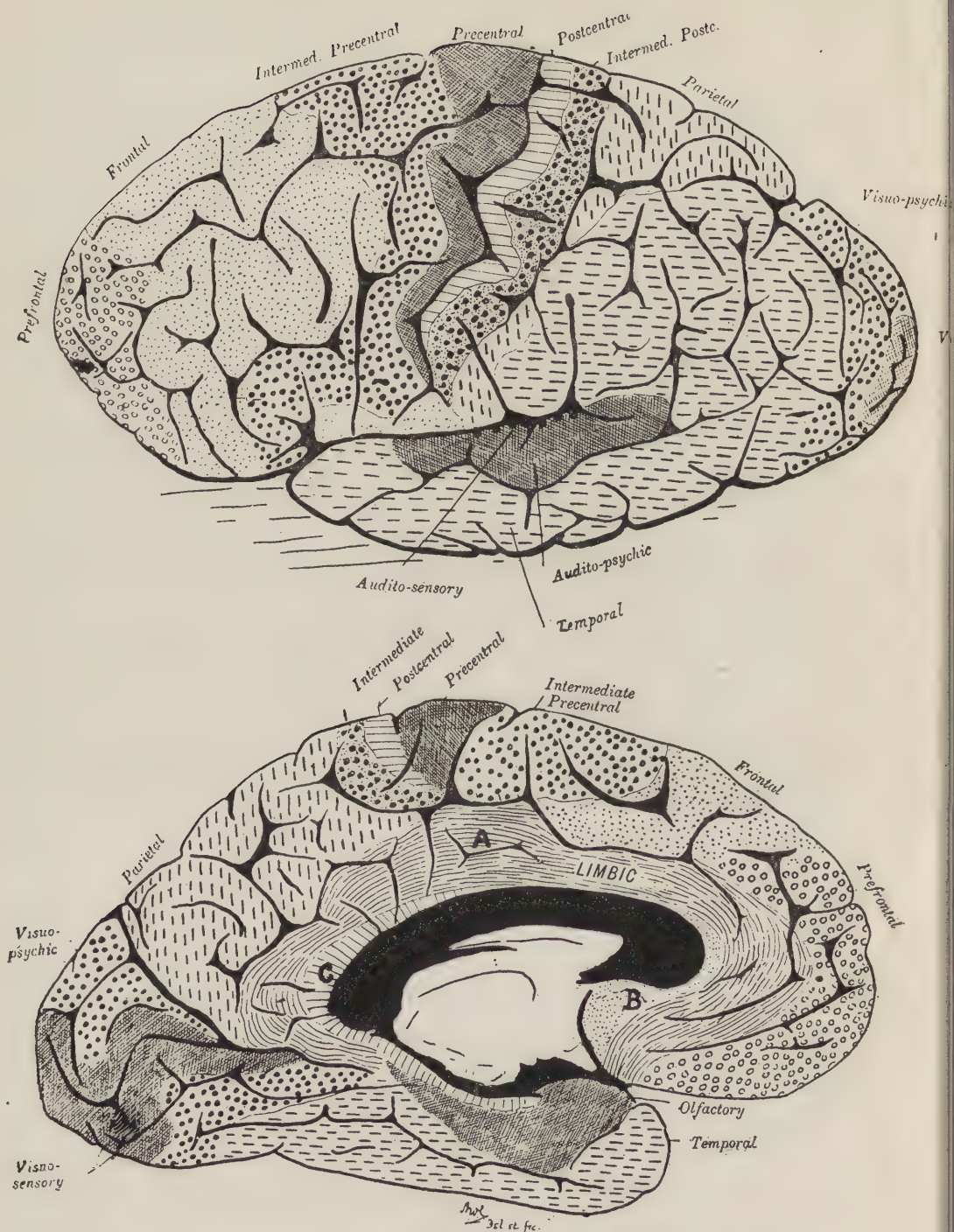
¹ Gehirn und Seele, 1896.

² Flechsig, P., Untersuchungsmethoden der Grosshirnrinde.—*Arch. f. Anat. u. Physiol.*, 1905, 337.

³ Localization of cerebral function, 1905.



PL. I. Myelogenetic areas, primordial, intermediate and terminal zones (Flechsig).



PL. II. Histological localization of cerebral functions (Campbell).

prominent areas of cortex on the surface of the human cerebrum, which could be homologized with similar areas in the ape and higher mammalian brains (Plate II). These areas also corresponded in a remarkable manner to the general developmental subdivision of the cortex presented by Flechsig, thus furnishing corroborative evidence of the correctness and reliability of the methods. The almost exact correspondence in the ape of the plainly differentiated Betz cell area of cortex with the area of excitable motor cortex defined by Grünbaum and Sherrington furnished proof of the correctness of the interpretation of functional localization from structural differentiation, although the motor significance of the giant pyramidal cells of Betz had long previously been recognized by Lewis and Clarke.¹ The frequent coincidence of area limits with important fissures was especially noted by Campbell and led to the statement that the fields governing the functions we have hitherto succeeded in locating are all deposited in direct relation to some important sulcus, which in one direction at any rate, forms a sharp and perfect boundary.

A similar histological survey of the human cerebral cortex was presented by Brodman,² which represented the final result of several years of comparative study of the histological localization in the cerebral cortex throughout the entire mammalian class of vertebrates, and in which he delineated fifty-two different cortical areas in the human brain (Plate III). These areas he grouped into eleven regions or principal fields: the postcentral (tactile), the precentral (motor), the frontal (association), the insular, the parietal (association), the temporal (auditory), the occipital (visual), the cingular, retrosplenial, hippocampal, and olfactory, the general agreement of which to the subdivisions of Flechsig and Campbell is very evident. According to Brodman the structural peculiarities characteristic of each area are sharply limited, so that it is fairly easy in serial sections to recognize and fix the limits which mark off each area from the adjoining regions. He also called attention to the significant fact that, while the greater number of the fields thus defined have, as far as is known, no connection with actual physiological functions, some of the areas, and precisely those which are characterized by conspicuously different structure, coincide with or are directly related to the regions whose functions are known from experimental physiological research or clinical observations. Little emphasis, however, was placed upon the significance of

¹ Cortical localization of the motor area.—*Proc. Roy. Soc.*, 1878, No. 185.

² Die Cortexgliederung des Menschen.—*J. f. Psychol. u. Neurol.*, 1908, x, 231.



PL. III. Histological localization of the cerebral cortex (Brodmann).

fissures as area boundaries, for in the smaller subdivisions of the less differentiated cortex they often showed no boundary correspondence, although plainly preserving this relation in the more differentiated regions emphasized by Campbell.

The most successful attempt to define the significance of the fissures in their variable relation to the cortical areas of the cerebrum is the work of Elliot Smith.¹ The significance of this work, or wherein it differed from previous structural localizations, was the identification of area limits in the fresh brain by means of knife section and macroscopic examination of the cut surface. This permitted a much greater amount of material to be examined and conclusions to be drawn from the general or average relation of area limits to fissures, a feature which is often obscured by individual variations in the small series of hemispheres necessitated by the more detailed histological method. The accuracy of this macroscopic delimitation of cortical areas, based upon abrupt changes in the myelo-architecture of the cortex, is supported by the general correspondence of the areas with those established by the histological method and the coincidence with known functional areas. In agreement with Campbell and Brodman, Smith claimed that the changes in structure between areas occur with the utmost abruptness, which can most easily be seen in the limits of the area striata, making it possible to determine with precision the exact boundaries of each area. His conclusion on the fissural significance was that the vast majority of the furrows on the surface of the hemisphere present a definite causal relationship to some given cortical area or areas, and on this basis he constructed a new type map of the cerebral cortex with the areas plotted in definite relation to the main fissures as limiting, axial or operculated sulci² (Plate IV). The application of this method has resulted in a modified phylogenetic interpretation of the occipital sulci and has furnished in the other regions of the hemisphere a diagrammatic representation of fissures in relation to cortical areas, which aids greatly in the identification and comparison of different regions of the cortex (Plate IV).

The general trend of all of this work upon cerebral localization and fissural significance, both physiological and structural, has been in a sense a return to the old idea of Gall and Spurzheim of a cortical mosaic, each localized area presumably representing a distinct or modified function. A significant difference, however, of the present

¹ A new topographical survey of the human cerebral cortex.—*J. Anat. & Physiol.*, 1907, xli, 237.

² The central nervous system.—*Cunningham's Textb. of Anat.*, 4th ed., 1914.

conception of cerebral localization is that it is established around a number of primary sensory or motor functions and areas, with adjoining or surrounding localized differentiation of the primary type cortex, presumably representing an elaboration of this function, psycho-sensory or psycho-motor areas; and finally that it shows a remaining or intervening portion of less differentiated cortex of latest development ontogenetically and phylogenetically, the so-called association areas of Flechsig. The extensive comparative work has shown that there is a similar localization of function and structure in all mammals, in fact in the entire vertebrate kingdom, with the difference only that this localization receives its greatest elaboration and differentiation in the higher apes and man, the most striking feature being the great increase in size of the association areas. A homology of fissures has been fairly well established from the lowest mammals to man with the significant deduction that the main fissures develop primarily in the regions of differentiation of structure and function, but are frequently separated from this relation by the greater tendency of the fissures to remain stationary, through their closer relation to the underlying central masses of the hemisphere, than the more plastic and remote cortical areas which necessarily make the first response to increase or reduction of function in the evolution of the brain.¹

The anthropological significance of these advances in cerebral interpretation is the possibility, in fresh and properly preserved material, of a more accurate recognition of cortical areas, their boundaries and functions, a comparison of such areas by measurements and the establishment of racial and intellectual differences by this means. That this is not a hopeless task is well indicated by comparison of the area striata of the occipital region in different races and individuals, from which it has been established that this area is generally more extensive on the lateral surface of the negro brain than the white brain and more extensive in the left hemisphere than in the right.²

The application of such principles and methods to poorly preserved and hardened material is necessarily very limited, due to lack of history, to shrinkage and distortion. The attempt has been made in this series of Indian brains to apply this increasing knowledge of cortical localization and fissural significance by superposing the cortical

¹ Kappers, C. U. A., Cerebral localization and the significance of sulci.—*Seventeenth Internat. Cong. Med.*, 1913.

² Smith, G. E., Morphology of the human brain.—*Recs. Egypt. Gov't. School of Med.*, 1904, ii.

plan of Smith¹ upon the delineated fissures and intervening gyri of each hemisphere. No claim is made to represent by this method the exact boundary lines of very many cortical areas. The original plan is a small per cent type condition deduced from the study of negro brains, to which it is more applicable. In the more highly developed brain the variation and irregularity of fissure relation to cortical areas increases and it is doubtful if this method of interpretation of cortical areas is sufficiently accurate to permit valuable comparison, since it does not represent the concealed area of cortex which bears the relation of about two to one of the superficial cortex. Yet it does aid in the interpretation of fissures in a uniform manner and on a proper basis and emphasizes the greater importance of the gyri as representing cortical areas. Also it shows at a glance, by comparison with the type figure of Smith, the interpretation of the fissures without confusing labels and detailed description.

The plan used in the illustrations consisted of the tracing in ink of the fissures, representing by interruption and intervening dash the site of the more prominent submerged bridging gyri, and the plotting of the areas in relation to the fissures which are generally recognized as approximate boundaries. In many regions of irregular fissuration and unbounded transitional lines the borders of the areas were more or less arbitrarily defined and perhaps bear little relation to the exact limits of the areas. This necessity, however, in an at all regularly fissured region formed a relatively small part of any single large area and perhaps does not entirely preclude a remaining comparative value. The descriptive part of the text is intended only to call attention to those points that may be of interest in identification and comparison, as the detailed disposition of the fissures can be observed from the figures. The difference in size of the brains, due largely to fixation, has been equalized in the figures by reducing all to the same length, which, although not allowing for original undetermined differences in size, permits a better regional comparison.

INDIAN BRAIN No. 1

(Catalogue No. 226552. Plates V to VIII)

This brain was from a full-blood Tonto Apache Indian and of the three specimens of this study showed the least distortion from fixation. However, it showed considerable flattening on the superior surface and shrinkage and hardening from fixation in Muller's fluid. The

¹ The central nervous system.—*Cunningham's Textb. of Anat.*, 4th ed., 1914.

weight of the parts of the brain, with the membranes removed from the cerebral hemispheres, was as follows:

Right hemisphere.....	weight	370 gms.,	length	156 mm.
Left hemisphere.....	"	385 "	"	156 "
Brain-stem.....	"	130 "		
Total.....	"	885 "		

From this is seen the great shrinkage that has taken place, for there is no indication from the fissuration of a below normal brain. The inequality between the two hemispheres has no significance for it could be entirely due to the division of the hemispheres considerably to the left of the midline. The distortion and great shrinkage reduced to the minimum the value of comparative and relative measurements and as the other two brains were in even more unfavorable condition very little attempt has been made to record such measurements. Even in well-preserved specimens much doubt has been cast upon the rationality and practicability of past methods of comparison by the criticisms of Mall¹ and Brodman,² and it would be of very little value to undertake detailed measurement of poorly defined points and distances in this material.

The hemispheres present a fairly complex type of fissuration, there being few extensive areas not incised by prominent branches of adjoining sulci. The complexity, however, and tendency to transverse fissuration does not approach that observed by Bond³ and Schuster⁴ in the Chinese brain and by Hrdlička⁵ in the Eskimo brain. Considerable asymmetry is noted between the two hemispheres, which will be discussed in more detail under the different regions.

LATERAL SURFACE

The lateral cerebral fissure is similar in the two hemispheres with prominent upturned posterior extremity. The two anterior rami and the sulcus diagonalis are very distinct and widely separated in the left hemisphere but in the right the place of the sulcus diagonalis is taken by an apparent ascending ramus. This interpretation, however,

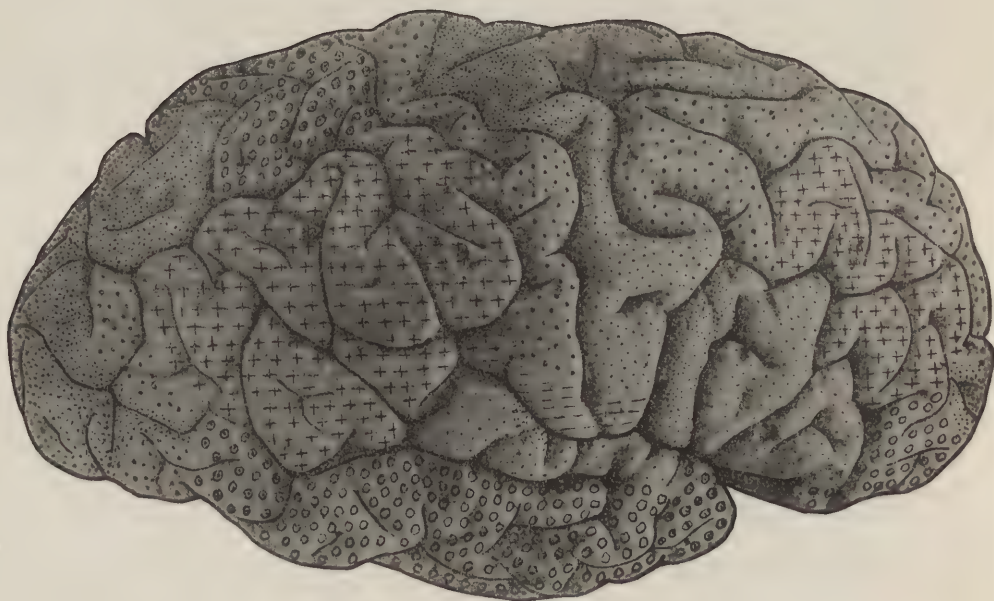
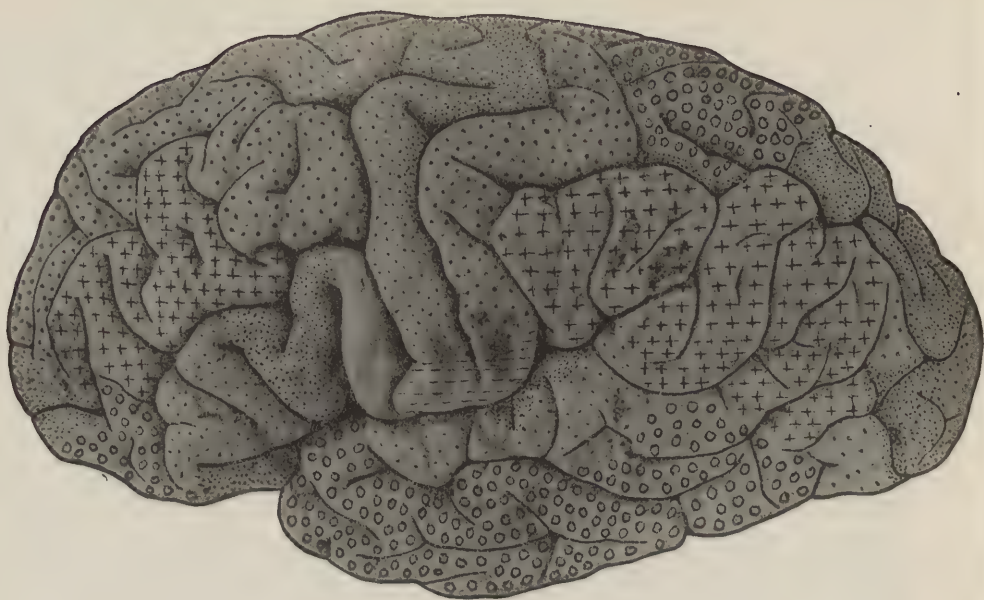
¹ Anatomical characters of the human brain.—*Am. J. Anat.*, 1909, ix, 1.

² Neue Forschungsergebnisse der Grosshirnrinden-anatomie.—*Verh. d. Vers. d. Naturf. u. Ärzte in Wien*, 1913.

³ Observations on a Chinese brain.—*Brain*, 1894, xvii.

⁴ Descriptions of three Chinese brains.—*J. Anat. & Physiol.*, 1908-09, xlii.

⁵ An Eskimo brain.—*Am. Anthropol.*, 1901.



Pl. V. Indian brain No. 1.

can hardly be made without deeper examination of the manner of communication with the main fissure, which is impossible in this specimen.

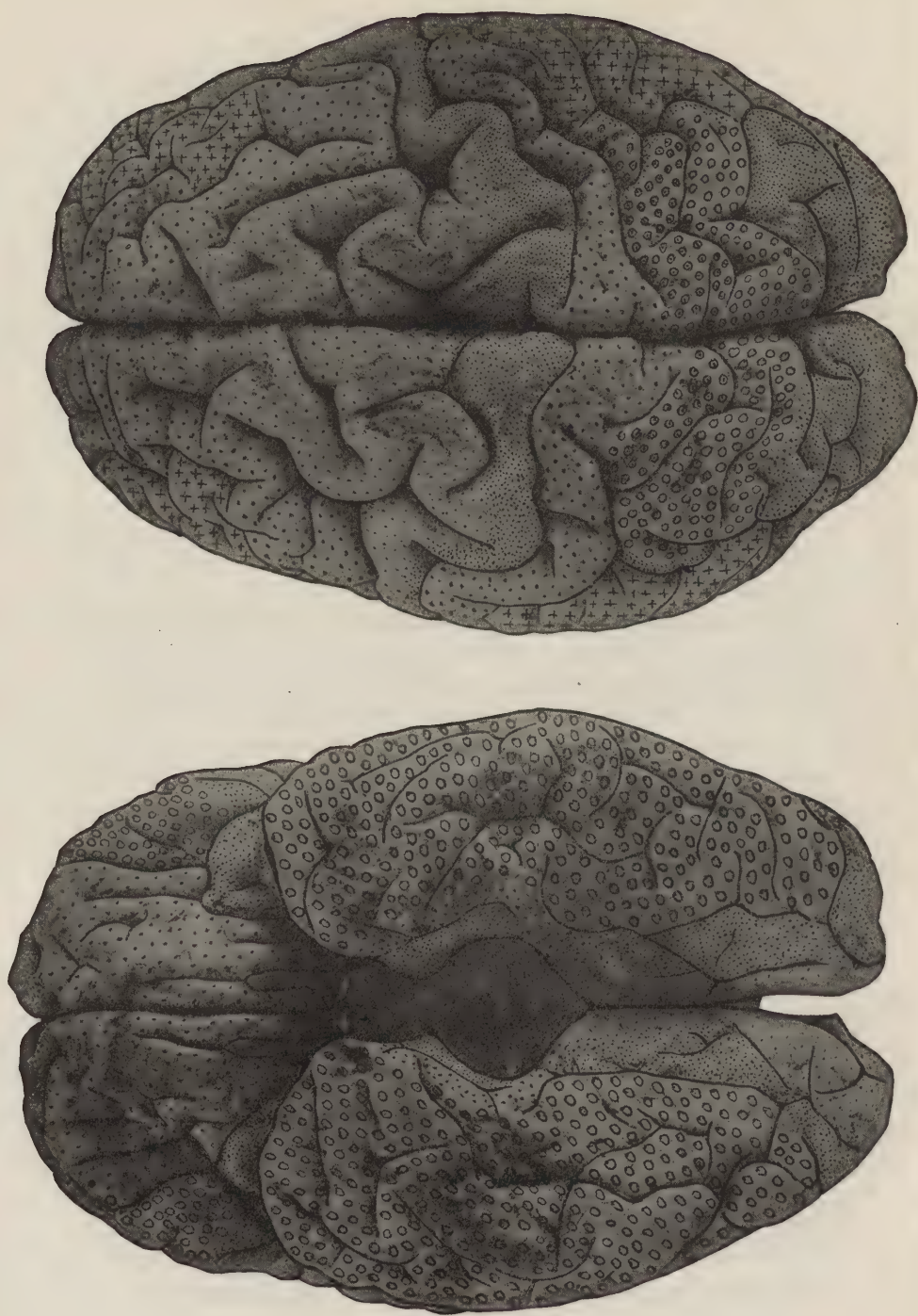
The sulcus centralis has an unusual tortuosity in the left hemisphere, with a length of 83 millimeters as compared with 75 millimeters in the right. It crosses the mesial border in the left hemisphere but not in the right.

The sulci precentrales, superior and inferior, are superficially continuous in the left hemisphere except for a detached tri-radiate element near the mesial border, Cunningham's¹ sulcus precentralis marginalis. This makes a continuous and even boundary for the lower two-thirds of the precentral cortex and quite prominent superior and inferior genua. In the right hemisphere the sulcus is represented by the three separate elements. The gyrus or area precentralis is notably different on the two sides, especially in the inferior region where the sulcus precentralis inferior is a generally recognized boundary. This suggests a functional difference between the two sides.

The sulcus frontalis superior represents excellently the typical disposition as three diagonal elements, the posterior in communication with the sulcus precentralis superior and the anterior possibly interpreted as the sulcus frontalis medius in communication with the sulcus fronto-marginalis. Following the cortical plan of Smith, the superior and anterior frontal areas adjust themselves very readily to the type of fissuration, showing the widening and anterior extension of the areas as the mesial border is approached, with the extension of the anterior frontal area between the two posterior elements of the sulcus frontalis superior. The similarity of the fissuration of the superior precentral and superior frontal regions in the two hemispheres is noteworthy.

The sulcus frontalis inferior is rather regular in the left hemisphere and completely bounds an inferior frontal area that agrees almost exactly in its fissuration with the type plan. An elevated posterior portion of the area, incised by the prominent sulcus diagonalis and corresponding to the motor speech center, suggests a functional significance. In the right hemisphere the sulcus frontalis inferior is more irregular and unusually high on the frontal surface, especially in the posterior region, thus giving to the inferior frontal area a greater superficial extent than in the left hemisphere. But comparison of superficial extent in this region is especially liable to be fallacious on

¹ Surface anatomy of the cerebral hemispheres.—Roy. *Irish Acad.*, 1892.



PL. VI. Indian brain No. 1.

account of the large per cent of cortex concealed in the superior wall of the lateral cerebral fissure, which could not be examined in this specimen.

The sulcus frontalis medius, on the basis of the interpretation of the three elements of the sulcus frontalis superior, is represented only by irregular transverse branches or elements.

The sulcus postcentralis in both hemispheres lacks fully two centimeters of reaching the lateral cerebral fissure and is compensated by an unusually large sulcus subcentralis posterior. In the left hemisphere it forms a large curve concentric with the prominent superior genu of the sulcus centralis at a distance of ten to fifteen millimeters. The course is much straighter in the right hemisphere and at a distance of only five to seven millimeters from the sulcus centralis, thus making a striking difference in the width of the gyrus or area postcentralis in this region. Since the fissures are rather constant boundaries to this cortical area the great difference between the two hemispheres must have a functional significance, possibly associated with right-sidedness in the body as the greater cortical area occurs in the left hemisphere.

The sulcus interparietalis and the sulcus paroccipitalis are quite irregular in the left hemisphere but rather typical in the right. This irregularity may be associated with the posterior convexity of the sulcus postcentralis. It consists of an anterior extension of the sulcus paroccipitalis to within three millimeters of the sulcus postcentralis, with very little indication of either an anterior or a posterior bifurcation. In the right hemisphere the inferior extension of the anterior extremity of the sulcus interparietalis and the prominent arcuate form of the sulcus paroccipitalis are noteworthy. The superior parietal area presents no points permitting comparison.

The sulcus lunatus is not typical in either hemisphere, the type of fissuration corresponding more to the sulcus occipitalis lateralis formed by a migration of the superior half of the sulcus lunatus to a position nearly in line with the sulcus prelunatus and a lengthening of the sulcus prelunatus. It is difficult to judge which approaches nearer to the arcuate form of sulcus lunatus but the more lateral extent of the sulcus postcalcarinus and consequently the area striata in the left hemisphere would indicate the more typical condition.

The sulcus temporalis superior is a recognized boundary for the acoustico-psychic cortex. The independence of the sulcus temporalis polaris (transversus) and the sulcus angularis (ascending ramus) is evident in both hemispheres. The superior temporal gyrus is narrower



PL. VII. Indian brain No. 1.

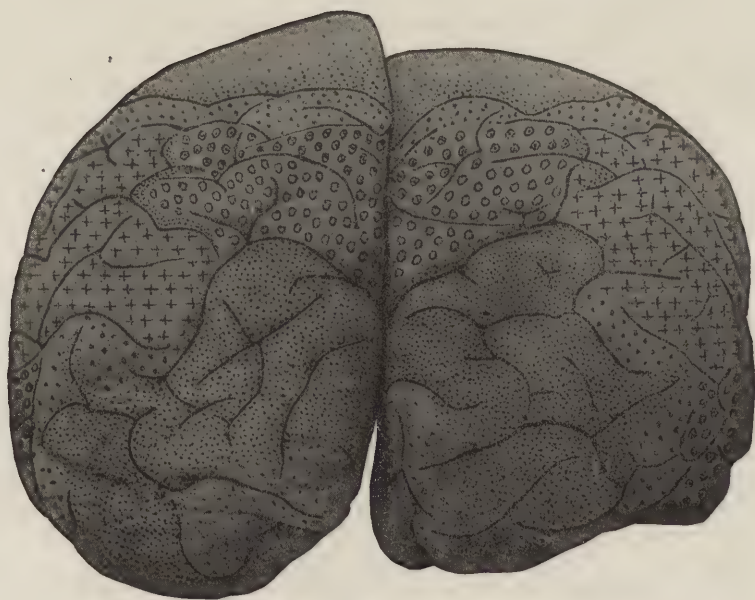
than usual in its superficial extent. It shows here, as in most brains, a tendency to a posterior communication with the visual cortex by bridging or superficial gyri. Flechsig¹ shows a narrow intervening area of cortex in this region that myelinates earlier than the parietal and temporal association areas and Smith² a strip of differentiated cortex. The same condition is illustrated by a special strip of cortex along the superior wall of the interparietal sulcus connecting between the somatic sensory and visual areas and suggests a remnant of an earlier more direct connection between these primary sensory centers. The location of the audito-sensory cortex, which just appears upon the superficial surface of the gyrus temporalis superior, can rather constantly be determined by a small branch of the lateral cerebral fissure which represents a continuation of the sulcus dividing the two transverse temporal gyri of Heschl. The audito-psychic area is defined below by the sulcus temporalis superior, anteriorly by the line of the inferior extremity of the sulcus centralis and posteriorly by the bifurcation of the lateral cerebral fissure.

The remaining cortex of the lateral cerebral surface, the inferior parietal and the middle and inferior temporal areas, are those representing in myelogenesis and supposedly function the latest development in the evolution of the cerebral cortex, excepting the frontal region which takes an intermediate position between the parietal and temporal. The outline of the inferior parietal area is fairly well defined by the boundaries of surrounding more primitive areas. The anterior boundary is formed by the sulcus postcentralis and the sulcus subcentralis posterior and the superior by the sulcus interparietalis and the sulcus paroccipitalis. The inferior limit is the lateral cerebral fissure and a rather constant but irregular series of communications between the lateral cerebral, the superior and middle temporal, the anterior and lateral occipital fissures. The posterior boundary is typically the sulcus occipitalis anterior but the irregularity of this sulcus often results in uncertainty of definition. The typical fissuration of this inferior parietal area is well illustrated in the left hemisphere of this brain, the area being divided into anterior and posterior parts by a prominent descending branch of the sulcus interparietalis. This branch, according to the maps of Smith, Brodman and Flechsig marks a line of cortical differentiation. Cole³ has called attention to these

¹ Untersuchungsmethoden der Grosshirnrinde.—*Arch. f. Anat. & Physiol.*, 1905.

² A new topographical survey of the human cerebral cortex. *J. Anat. & Physiol.*, 1907, xli, 237.

³ On some morphological aspects of microcephalic idiocy.—*J. Anat. & Physiol.*, 1910, xliv.



Pl. VIII. Indian brain No. 1.

areas, claiming a predominance of growth in the anterior to be more characteristic of the ape brain, and the opposite in the highly developed human brain. Comparison of the two hemispheres shows very plainly the greater posterior representation in the right, interpreting the descending branch of the sulcus interparietalis as the dividing line. The boundaries and fissuration of the frontal and temporal association regions are not definite enough to permit comparison.

MESIAL SURFACE.

The sulcus centralis does not extend to the mesial surface in the right hemisphere and consequently the extent of the motor area in the paracentral area is not well defined. Campbell¹ calls attention to a more or less horizontal curved sulcus paracentralis, suggested as the possible homologue of the sulcus cruciatus of lower mammals, which is frequently the inferior and posterior boundary of the motor area in this region. Smith² shows this element as a boundary and both are agreed that the motor cortex does not reach the sulcus cinguli. In the left hemisphere the boundaries are somewhat better indicated. The posterior part of the sulcus cinguli, bounding the paracentral lobule, is typical in the left hemisphere but fails to incise the superior border of the hemisphere in the right, bifurcating on the mesial surface. The anterior part of the sulcus cinguli is also radically different in the two hemispheres, but the correct interpretation of this part is often difficult on account of the frequent compensatory relation it bears to the sulcus frontalis marginalis. The areas plotted in this region are of doubtful significance.

The lobulus precuneus in the left hemisphere is rather typically divided into two regions of cortex by the horizontal sulcus subparietalis. The posterior part of the sulcus is lacking in the right hemisphere. The superior part of the lobule belongs to the superior parietal type of cortex, the inferior to the cingulate.

The calcarine fissure and the fossa parieto-occipitalis could not be examined in their depth, hence the prominence of bridging gyri could not be determined. In both hemispheres there is an unusual extent of the incisura parieto-occipitalis on the lateral surface but no communication with the sulcus paroccipitalis. In the left hemisphere the gyrus intercuneatus, which separates the three elements of the fossa, is almost superficial at the border of the hemisphere.

¹ Localization of cerebral function, 1905.

² The central nervous system.—*Cunningham's Textb. of Anat.*, 1914.

The postcalcarine sulcus terminates in a prominent polar bifurcation in the left hemisphere, more lateral and more typical than in the right, thus denoting a greater lateral extent of the area striata in the left hemisphere, a condition which may be considered normal in most brains. The area striata, although not delimited by section, could be plotted with a fair degree of accuracy due to its rather constant relation to the posterior bifurcation of the sulcus postcalcarinus and the general coincidence of its boundary on the mesial surface with shallow superior and inferior limiting sulci of the cuneus and gyrus lingualis and with frequent superior and inferior polar occipital sulci.

The fissura rhinalis is entirely independent of the sulcus collateralis in both hemispheres, forming a boldly curved lateral boundary to the piriform area and communicating with the incisura rhinalis of the lateral cerebral fossa. The sulcus collateralis approaches the foetal type with its short anterior extremity and irregular posterior portion.

INDIAN BRAIN NO. II

(Catalogue No. 226554. Plates IX to XI)

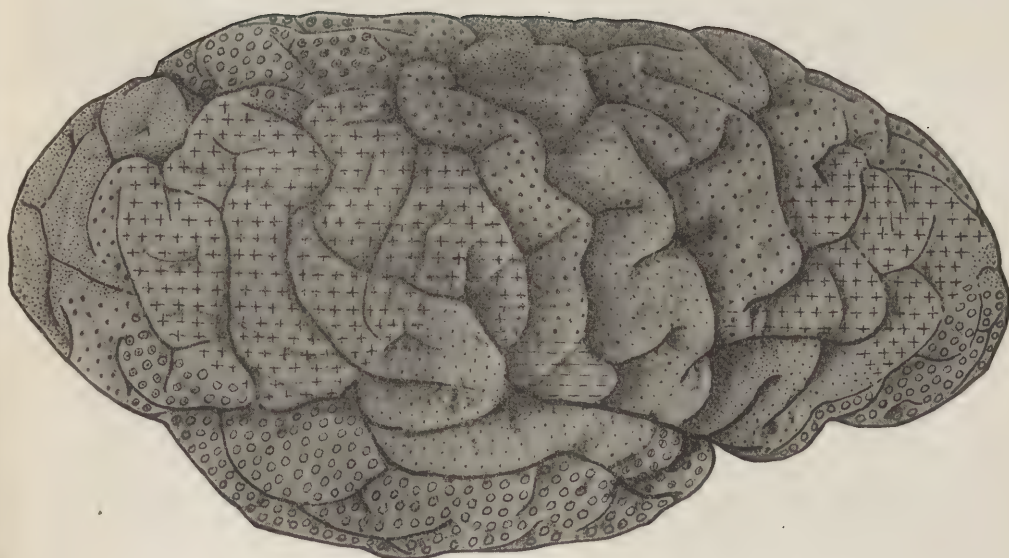
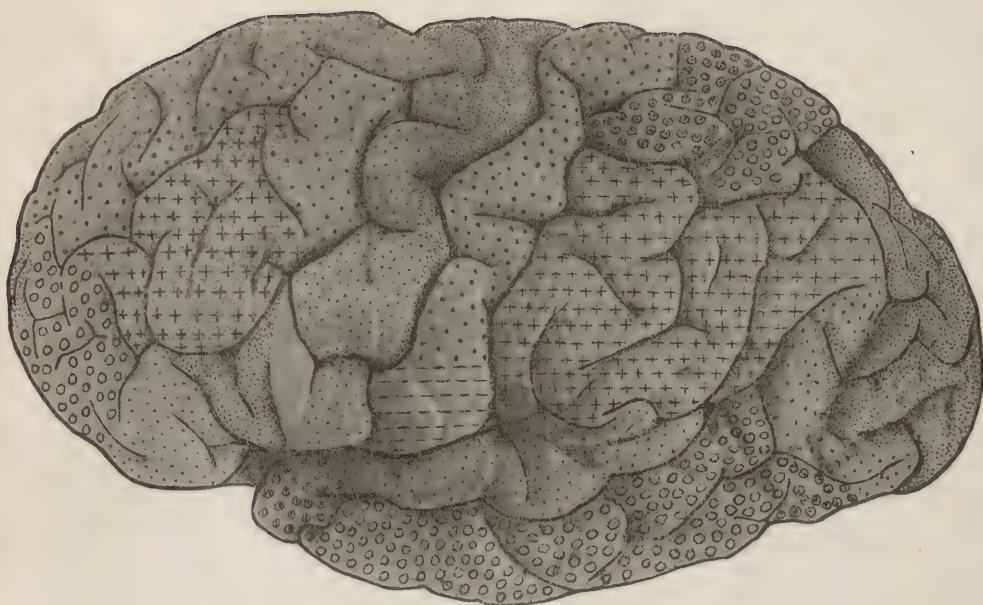
This second specimen of a full-blood Tonto Apache Indian brain also was hardened in Muller's fluid outside of the cranial cavity and had suffered so much distortion and shrinkage that measurements would be of practically no value. However, the following weights are given to show the extreme shrinkage that must have taken place:

Right hemisphere.....	weight	337	gms.,	length	149	mm.
Left hemisphere.....	"	335	"	"	149	"
Brain-stem.....	"	125	"	"		
Total.....	"	797	"			

The hemispheres presented a simpler type of fissuration with broader and more regular gyri than Brain No. I, notwithstanding the smaller size of the brain. This difference is perhaps emphasized to some extent in the figures by the equalization of the longitudinal measurements. The width of the gyri in the central region is especially noticeable.

LATERAL SURFACE

The lateral cerebral fissure is rather short in both hemispheres with a more pronounced upturned extremity in the right. The anterior limbs are of the "V" or beginning "Y" type with the ramus



PL. IX. Indian brain No. 2.

horizontalis placed rather low, almost upon the orbital surface. An unusual condition in both hemispheres is a communication with all three vertical central fissures through the intermediation of the subcentral elements. The superficial extension of the sulcus dividing the two transverse temporal gyri of Heschl is very evident in both hemispheres.

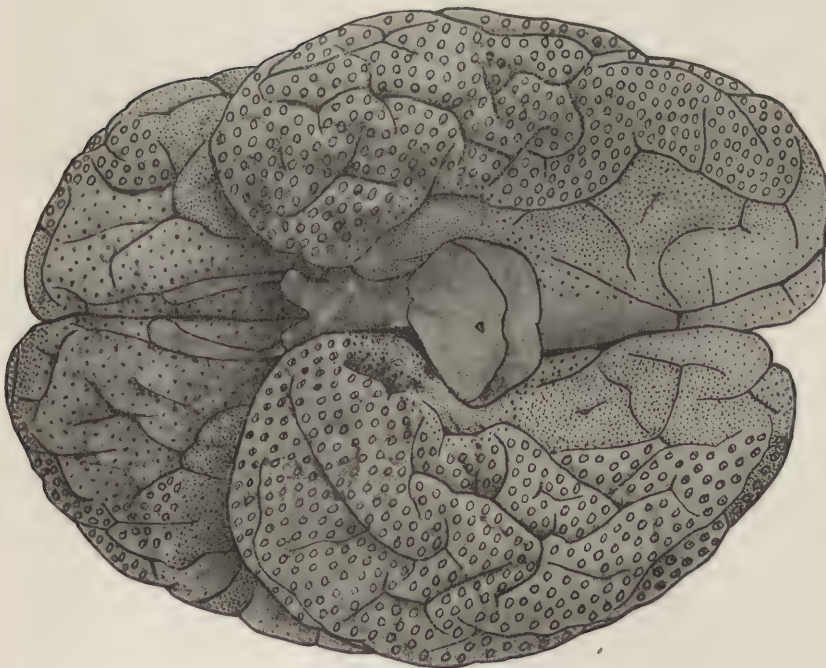
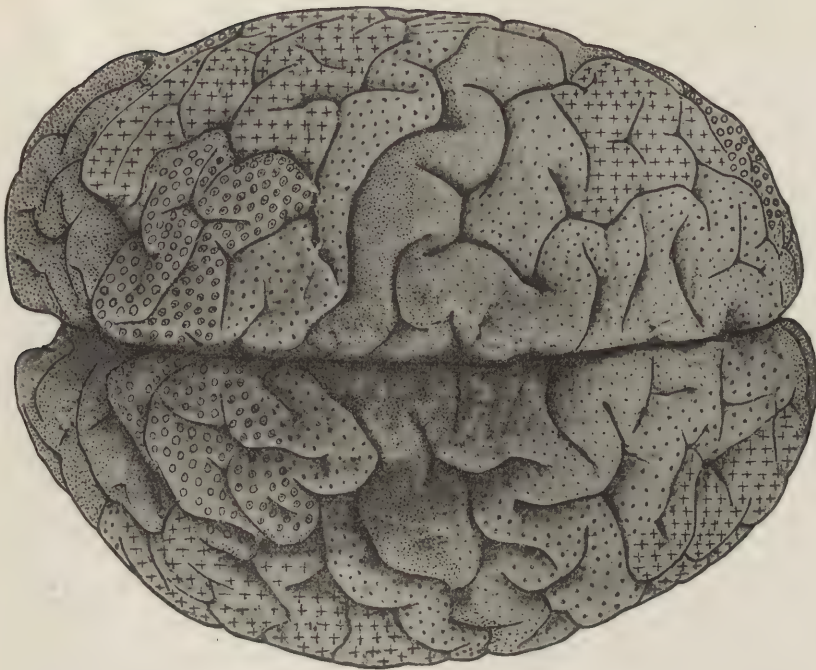
The sulcus centralis communicates with the lateral cerebral fissure in both hemispheres through the sulcus subcentralis anterior. It extends typically to the mesial surface on both sides, with a much straighter course than in Brain No. I. The superior genu again is more pronounced in the left hemisphere.

The sulci precentrales are separated in the right but are in shallow communication in the left hemisphere. They are rather typical of Cunningham's description, including the sulcus precentralis marginalis on the left side. The gyrus precentralis, corresponding to the area precentralis in the lower two-thirds, is of about uniform width throughout, only slightly expanded in the region of the superior genu. The general size appears proportionately larger than usual with a distinct enlargement of the lower part in the left hemisphere due to the anterior convexity of the sulcus precentralis inferior.

The sulcus frontalis superior has an unusual position and course in the left hemisphere, receding slightly from the mesial border towards the frontal pole, thus resulting in a rather wide anterior frontal area and narrow middle frontal area. The definition of this sulcus as a boundary line is uncertain, however. On the right side the more typical oblique arrangement of elements is found.

The sulcus frontalis inferior is continuous in the left hemisphere from the sulcus precentralis inferior to the orbital border. In the right it is much shorter although bearing the same relation to the ascending rami of the lateral fissure. The left inferior frontal area consequently is well defined but the right is lacking in an anterior superior boundary. The left ascending ramus of the lateral cerebral fissure is situated much farther anterior than the right, thus leaving a wide posterior inferior frontal area on this side which is incised by a sulcus diagonalis and descending branch of the sulcus frontalis inferior.

The sulcus postcentralis is continuous in both hemispheres from the lateral cerebral fissure to a shallow communication with the sulcus centralis near the mesial border. The gyrus postcentralis, corresponding in boundaries to the area postcentralis, is of greater extent in the left hemisphere but not to the degree noted in Brain No. I.



Pl. X. Indian brain No. 2.

The sulcus interparietalis is similar on the two sides but situated more lateral on the left. The descending branch is quite prominent, more so in the left where it appears to compensate for the short lateral cerebral fissure.

The sulcus paroccipitalis is typical in the right but irregular in the left hemisphere on account of the lateral deflection of its posterior part. On both sides is to be noted the communication with the incisura parieto-occipitalis.

The sulcus lunatus is represented in both hemispheres in a stage of transition to the sulcus occipitalis lateralis by the conversion of the sulcus prelunatus and the superior half of the sulcus lunatus into a longitudinal fissure parallel to the lateral border of the hemisphere. Very little difference between the two sides can be detected but judgment is complicated by a partial destruction of this region of cortex in the left hemisphere, thus leaving the more easily defined sulcus lunatus in the right hemisphere. This is contradicted, however, by the more lateral extension of the sulcus postcalcarinus in the left hemisphere, which predicates a greater lateral extent of the area striata and more typical sulcus lunatus. The limits of the area striata plotted on this basis, about a centimeter distant from the sulcus postcalcarinus and related to superior and inferior polar occipital sulci, is more restricted to the mesial surface than in Brain No. I. The limits of the area peristriata are approximated to the sulcus paroccipitalis, the inferior limb of its posterior bifurcation, the sulcus prelunatus and the sulcus occipitalis inferior.

The sulcus temporalis superior has a distinct arcuate form limiting the audito-psychic area, more pronounced in the right hemisphere. This increased size of the area, combined with the prominent incising transverse temporal sulcus of Heschl, suggests a greater functional significance than usual. The sulcus angularis is quite well developed but situated more posterior in the right hemisphere.

The inferior parietal cortex has very well defined boundaries and a distinct division into anterior and posterior areas by the prominent descending branch of the sulcus interparietalis. The entire area appears more extensive in the right hemisphere. The two subdivisions are of nearly equal size in the left hemisphere, the posterior being incised by the sulcus angularis and limited by a typical sulcus occipitalis anterior. In the right hemisphere the posterior area is distinctly the larger, denoted by the more anterior position of the sulcus angularis and the presence of a sulcus intermedius, posterior to this sulcus.



PL. XI. Indian brain No. 2.

MESIAL SURFACE

The sulcus centralis is seen on the mesial surface in both hemispheres and the motor area is very easily plotted in relation to this termination and a somewhat horizontal sulcus paracentralis. The lobulus is completely bounded by a typical posterior element of the sulcus cinguli which incises the border of the hemisphere just posterior to the sulcus centralis. The anterior two-thirds of the sulcus cinguli is more regular than in Brain No. I and the areas of this region can be plotted very easily in correspondence with the type plan.

The lobulus precuneus presents a striking difference of size and fissuration in the two hemispheres, the right being narrow and the left unusually wide. This increased width is associated with an accessory sulcus in the posterior region, which deeply incises the superior or mesial border of the hemisphere to communicate with the sulcus paroccipitalis. This sulcus can only be interpreted as a completely separated sulcus limitans precunei of the fossa parieto-occipitalis, a very rare condition.

The calcarine and parieto-occipitalis complex of fissures could not be examined in their depth, consequently a doubtful interpretation is necessary. The superficial communication of the left sulcus calcarinus with the fossa parieto-occipitalis is located fully twice as far from the splenium of the corpus callosum as in the right hemisphere, which condition must be associated with the independent sulcus limitans precunei interpreted in the lobulus precunei. The analogous sulcus in the right hemisphere also communicates with the sulcus paroccipitalis but is here incorporated within the fossa parieto-occipitalis.

The sulcus postcalcarinus extends just to the occipital pole in the right hemisphere and slightly beyond in the left, but the latter termination is partially destroyed by an injury to the cortex in this region. The area striata boundaries are fairly well indicated by shallow limiting sulci in the cuneus and lingual gyrus and a very distinct sulcus occipitalis polaris superior in the right hemisphere arching around the bifurcation of the sulcus postcalcarinus.


The fissura rhinalis represents an advanced type of development with complete separation of the posterior part from the incisura rhinalis and a full communication with the sulcus collateralis.

INDIAN BRAIN No. III

(Catalogue No. 228483. Plates XII to XIV; Fig. 1)

This brain was from a full-blood Teton Sioux Indian and formaldehyde fixation permitted the walls of the fissures to be separated and examined. However, it was the most distorted of the three specimens and in addition was injured by a deep incision in the lateral surface of both hemispheres, extending from the incisura parieto-occipitalis across the parietal and temporal cortex to the anterior part of the lateral cerebral fissure. The weight of the brain was nearer normal than the preceding two as is seen from the following figures:

Right hemisphere.....	weight 545 gms.,	length 166 mm.
Left hemisphere.....	" 543 "	" 173 "
Brain-stem.....	" 140 "	
Total.....	" 1,228 "	

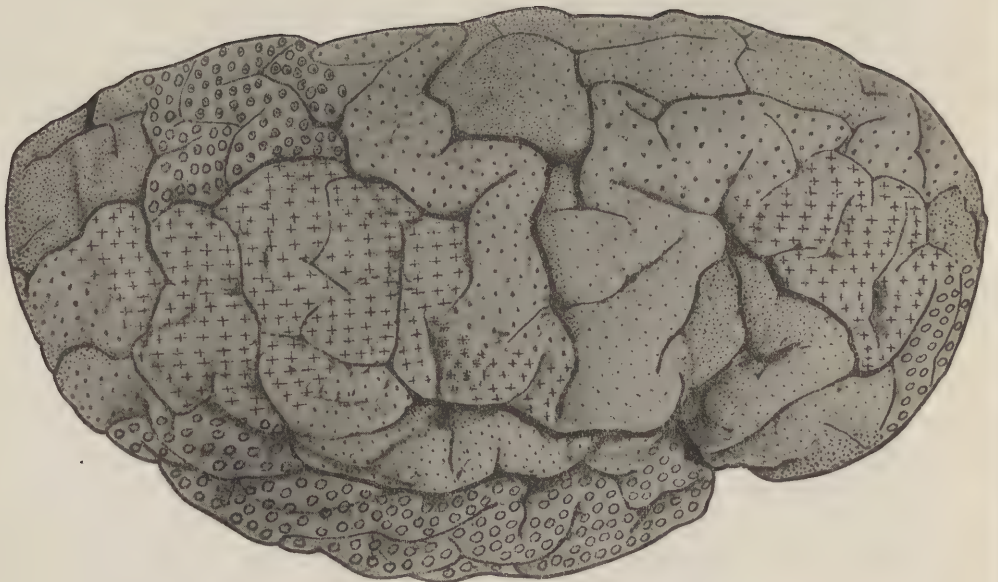
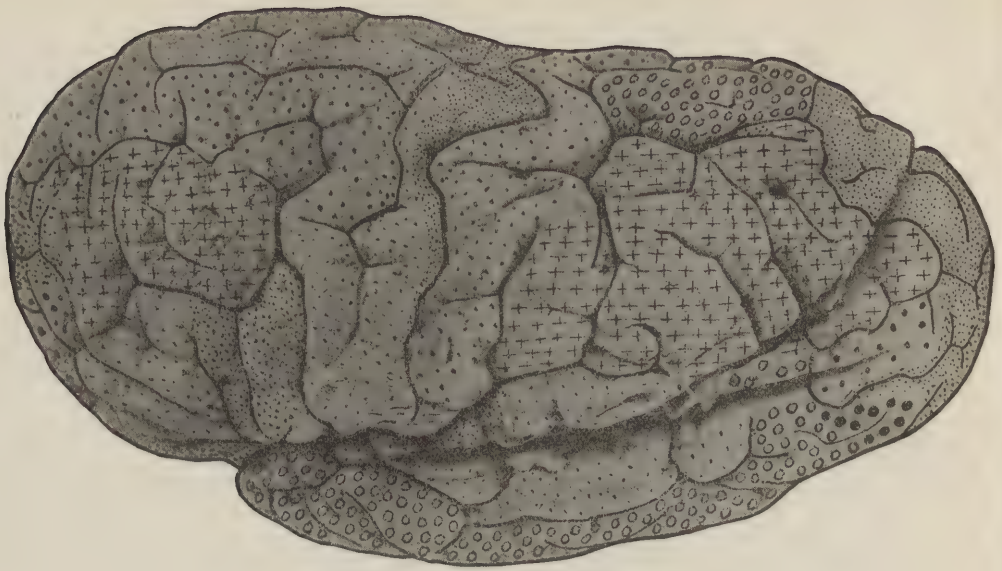
Practically nothing can be judged from the weight concerning the original or relative size of this brain. The type of fissuration has a peculiar angular appearance due to late fixation in the membranes and flattening of the surface of the gyri. This irregular appearance, however, certainly has a structural basis in the lower central region. The complexity of the fissuration in the plotted figures does not appear greater than normal. 

LATERAL SURFACE

The lateral cerebral fissure presents nothing unusual except a considerable irregularity in the region of the ascending ramus of the right hemisphere, where there is a communication with a prominent descending branch of the sulcus frontalis inferior.

The sulcus centralis hardly reaches the mesial border in either hemisphere, although compression in this region has made the exact line of the border difficult to determine. The superior and inferior genua are accentuated, perhaps due to the flattening of the surface. A communication with the sulcus precentralis is noted in the right hemisphere.

The sulcus precentralis superior is completely separated from the sulcus precentralis inferior in both hemispheres and has an unusual length and course, extending below into the gyrus precentralis and terminating in a transverse bifurcation. The sulcus precentralis inferior is rather distant from the sulcus centralis, especially in the



PL. XII. Indian brain No. 3.

right hemisphere, thus giving rise to a wide area precentralis in this region.

The sulcus frontalis superior has the typical oblique element disposition on both sides, fitting well with the antero-mesial extension of the cortical areas in this region.

The sulcus frontalis inferior in the right hemisphere extends from the sulcus precentralis inferior to a very prominent anterior bifurcation or sulcus radiatus, but in the left hemisphere is separated from this transverse part by a narrow gyrus. A prominent descending branch incises the posterior part of the inferior frontal gyrus on both sides, but takes origin in the right hemisphere from the communication with the sulcus precentralis inferior and communicates with the ascending ramus of the lateral cerebral fissure and with the sulcus diagonalis. The posterior part of the inferior frontal area is smaller in the right hemisphere. The pars triangularis is incised by the sulcus radiatus in both cases.

The sulcus postcentralis resembles that of Brain No. I by terminating a considerable distance from the lateral cerebral fissure and being compensated by the sulcus subcentralis posterior. The width of the area postcentralis is about equal in both hemispheres.

The sulcus interparietalis communicates with the sulcus paroccipitalis in the right hemisphere but not in the left. The descending branch is of doubtful identity in both, possibly in communication with the sulcus angularis on the right side and as a short independent branch on the left.

The sulcus paroccipitalis, although interrupted by the deep cut in the lateral of the hemispheres, can be interpreted of rather typical form on both sides, the greatest variation being the long arcuate medial limb of the posterior bifurcation in the right.

The sulcus lunatus is completely converted into the sulcus occipitalis lateralis. A small arcuate sulcus near the occipital pole in the left hemisphere is interpreted, on account of its close relation to the posterior extremity of the sulcus postcalcarinus, as a lateral limiting sulcus for the area striata, not the sulcus lunatus but a combination of shallow elements which frequently mark the limits of the area striata. The mesial termination of the right sulcus postcalcarinus and the extension of the sulcus occipitalis lateralis nearer to the occipital pole in this hemisphere indicate a smaller lateral extent of the area striata than in the left.

The sulcus and gyrus temporalis superior were extensively destroyed



PL. XIII. Indian brain No. 3.

in both hemispheres by the deep cut in this region of the lateral surface. In the right hemisphere a continuous sulcus is interpreted, extending from the temporal pole to a communication with the sulcus interparietalis through the intermediation of the sulcus angularis and the descending branch of the sulcus interparietalis. In the left hemisphere the sulcus angularis is situated more posterior and an accessory sulcus lies between it and the termination of the lateral cerebral fissure. This suggests the greater growth in the anterior parietal cortex of the left hemisphere.

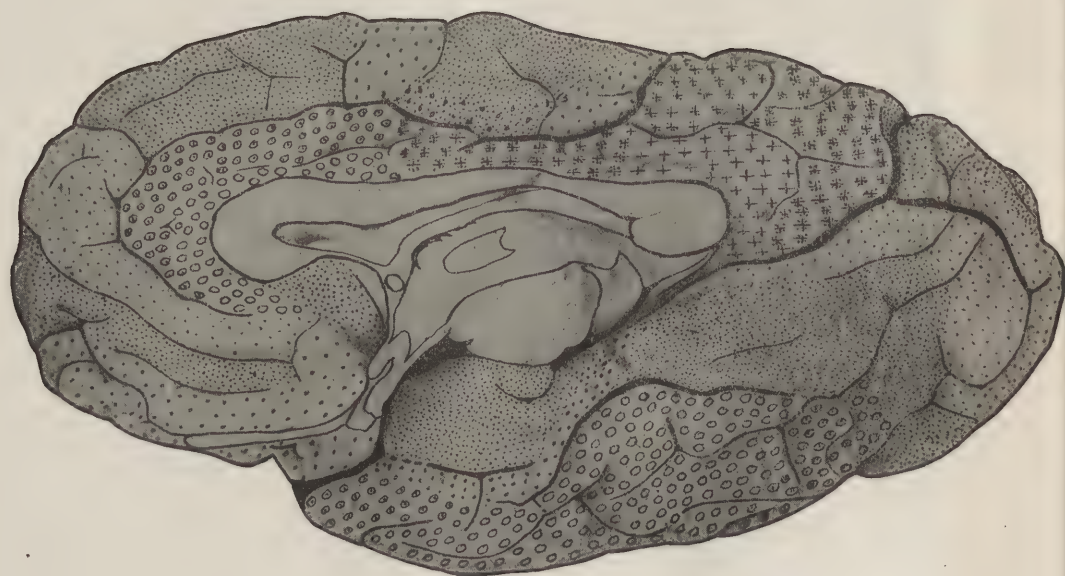
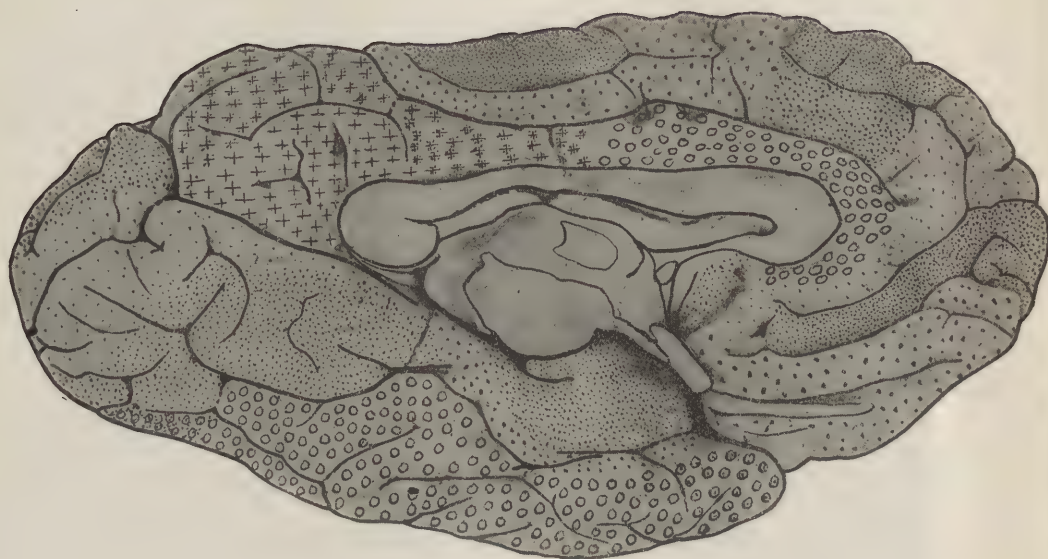
MESIAL SURFACE

The left paracentral lobule contains a horizontal element interpreted as the inferior and posterior boundary of the motor cortex. The right is less definite. The posterior part of the sulcus cinguli forms a complete posterior and inferior boundary for the lobule on both sides, deeply incising the superior border of the hemisphere and arching around the posterior extremity of the sulcus centralis. The anterior two-thirds of the sulcus cinguli appears in the position of the sulcus frontalis marginalis in the right hemisphere and is incomplete in the left, thus confusing the interpretation of the areas in this region.

The lobulus precuneus is rather typically fissured in both hemispheres. The postero-superior angle is incised by the sulcus limitans precunei of the fossa parieto-occipitalis.

The fossa parieto-occipitalis is very deep and partly destroyed by the cut in the lateral surface. In the left there is a wide separation of the three elements of the fossa, the sulcus limitans precunei, the sulcus incisura, and the sulcus paracalcarinus, resulting in an extension of the first into the lobulus precuneus, an entirely superficial lateral position of the second, and a deep incision of the border of the hemisphere by the sulcus paracalcarinus. Thus it may be said that the gyrus intercuneatus is superficial. In the right hemisphere this region, although injured to a greater extent, gave indication of a deeper position of the elements and separating gyrus intercuneatus, with the incisura appearing bifurcated on the lateral surface.

The sulcus calcarinus has a deep communication with the fossa parieto-occipitalis in both hemispheres, but an almost superficial bridging gyrus cuneo-lingualis anterior separates it from the sulcus postcalcarinus. A rather long anterior extension in shallow communication with the hippocampal fissure may be due in part to the artificial compression of the lingual gyrus.



PL. XIV. Indian brain No. III.

The sulcus postcalcarinus is rather short and situated nearer the superior border of the hemisphere than usual, but this may be due largely to the distortion of the brain. The posterior bridging gyrus cuneo-lingualis is present but less prominent than the anterior. The posterior termination or bifurcation is situated fully a centimeter more lateral in the left hemisphere than in the right. This agrees



FIG. 1. Indian brain No. 3, occipital surface.

with the usual condition and denotes a more lateral extent of the area striata on the left side. The superior and inferior limiting sulci of the area striata are not indicated very definitely, the tendency being more towards a transverse disposition of these shallow elements. The superior and inferior polar occipital sulci, bounding the area striata at the borders of the hemisphere, are both very distinct in the left hemisphere.

The fissura rhinalis approaches the primitive type, having an appreciable communication with the incisura rhinalis and a tendency to separation from the irregular deflected anterior extremity of the sulcus collateralis.

SUMMARY

The study of these three full-blood Indian brains permits little to be said from the standpoint of structural or racial differentiation, partly due to the imperfect preservation and small series but chiefly due to the fact that few exact points for comparison have been established in cerebral anthropology. It is safe to state, however, that in these Indian brains there is no discernible difference from the average brain of the white race. An observation perhaps also noteworthy is that in none of the brains is there a very close approach to the complex type of fissuration noted in the Chinese and Eskimo brain or in the most complex type of brain of the white race. But in none of the brains does the lateral extent of the sulcus postcalcarinus and related area striata and sulcus lunatus approach the typical condition frequently found in the negro brain. The nearest resemblance to this condition is found in the left hemisphere of Brain No. I where a prominent polar bifurcation of the sulcus postcalcarinus is present. Associated with this more primitive condition in this brain is the foetal or more primitive type of the fissura rhinalis in both hemispheres and the superficial gyrus intercuneatus in the left hemisphere. Perhaps next in advance stands Brain No. III with its intermediate type of fissura rhinalis, the prominent bridging gyrus cuneo-lingualis anterior in both hemispheres, and the superficial gyrus intercuneatus in the left hemisphere. Brain No. II, although characterized by rather wide and regular gyri, is farthest removed from the low type cerebrum by the numerous communication of fissures usually independent and by the complete fusion of the posterior part of the fissura rhinalis with the sulcus collateralis.

From an analysis of the literature on cerebral localization and fissural significance and from the study of the negro, Indian and white brain from the standpoint of cerebral anthropology, a few conclusions concerning the trend of work in this field and the possibilities for future investigations may be added. Detailed measurements on the cerebral surface have not established constant racial, sexual or mental differences, perhaps because of their fewness as yet in number, and because the possibility of error in the definition and selection of the landmarks is in some cases greater than the probable differences of race, sex or mentality. Further, such differences may be represented largely through finer organization of the inner structure of the cortex. The most valuable indications of degree of differentiation have been found in connection with the extent and type of cortical area differen-

tiation, to which the fissures play a secondary rôle but often furnish superficial evidence through their recognized relation to cortical areas. The most important example of this is found in the occipital region where the position and type of the sulcus lunatus bears a direct relation to the lateral extent of the area striata and is found more typical in the negro brain and especially in the left hemisphere. From this it is concluded that future possibility rests in the application of a better knowledge of area definition and extent in the comparison of brains and individual hemispheres. Three methods of attack of these problems are open: first is the comparison in the embryo of the early appearance of cortical elevations as the beginnings of area differentiations; second, a closer study of the development of the fissures in relation to cortical area differentiation to prove or disprove a large part of the suppositional significance of fissures; and third, a comparison by exact measurements, particularly of surface measurements of the more primitive and more differentiated cortical areas, with the remainder of the cortex representing the elaboration and association of these primary functions.

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THE NASO-ORBITO-ALVEOLAR INDEX

A NEW CRANIOMETRIC METHOD, INCLUDING A DESCRIPTION OF A SPECIALLY DESIGNED INDEXOMETER FOR ESTIMATING IT

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The author has been engaged for some time on a comparative study of measurements of the facial portion of the skull, and after some experimenting has been able to secure results that appear worthy of being placed on record. He made a preliminary communication on the subject to the Royal Society of Canada in May, 1919, and since then was privileged to study the collection of crania in the Royal College of Surgeons Museum, London, England, during the summer of 1919, thanks to the kindness and courtesy of Dr. Arthur Keith. These investigations inspired the production of a specially designed indexometer, the description of which is now published for the first time. I can find no evidence of this "naso-orbito-alveolar" method having been previously utilized in craniometry.

All the investigations recorded in this memoir were conducted on adult male crania, the reason for this being that the orbital contours were found to vary with age and sex throughout all the racial types, where this comparison could be made. As the lower orbital margins were utilized for one of the horizontal planes in the research, it was therefore found essential to confine the study to one sex. As soon as a representative collection of female racial types can be secured, it is intended to carry out an independent investigation on these, along lines similar to those followed in this research.

Crania of the following races were examined: European, Ancient Egyptian, Hindoo, Chinese, Eskimo, Polynesian, North American Indian, Ancient Inca, Patagonian, African negro, Melanesian, aboriginal Tasmanian, and aboriginal Australian. I was also enabled, through the courtesy of the Bureau of American Ethnology, to utilize the photographic reproductions of the Muniz collection of ancient Inca crania in the 16th Annual Report of the Bureau of American Ethnology, and the plates in Hrdlička's memoir on the Lenape Indians (Bull. 62, Bur. Amer. Ethn.).

Several of the well-known types of fossil Hominidæ were also utilized in this research. I have never had the privilege of studying the actual specimens in the case of the Obercassel Cro-magnon man, the "old man" of Cro-magnon, the LaChapelle cranium or the Grimaldi remains, though I have frequently seen the Gibraltar Skull in the Royal College of Surgeons Museum. I was, however, enabled to apply my method to photographic reproductions of these taken from the works of Bonnet,¹ Boule² and Verneau³ and from the plates illustrating Hrdlička's memoir on types of fossil Hominidæ. ("The Most Ancient Skeletal Remains of Man," 2 ed., 8°. Smiths. Inst., 1916.)

The naso-orbito-alveolar index may be calculated in two ways: (1) by drawing certain lines on photographs of the skulls, or (2) by using the author's specially designed indexometer (Fig. 1).

In regard to the photographic method, it was essential that the orientation of the skulls should be exactly the same in all cases, and it was found most convenient to use the Frankfort plane. One important point to be noted was that the relative levels of the camera and the skull had to be the same for each series of crania. The simplest way to ensure this was by focusing the midpoint between the nasion and the akanthion (point of nasal spine) on to the intersection of diagonal lines drawn on the ground glass screen of the camera. Horizontal lines were then drawn through the following four points on each photograph—the nasion, the lower orbital margins, the akanthion and the alveolar point. Two vertical lines were then drawn along the outer margins of the nasal aperture. It will be noted that three of the cranial points chosen possess a fair degree of positional constancy, and it may be further observed that the plan makes full use of the remarkably constant and trustworthy nasal index. It may be mentioned here that in the case of the LaChapelle skull a small piece of bone is absent from the region of the nasion, thus rendering the localization of this point only approximate. The horizontal line drawn through the lower borders of the orbits does not possess so high a degree of constancy as the others. Moreover, it was found that in some of the skulls the lower orbital margins were not on the same horizontal plane, in which case the mean of these was taken.

When these lines were drawn in the manner indicated, the result was an elongated rectangle; with the long sides placed vertically, and subdivided into three subsidiary rectangular areas (see the illustra-

¹ *Die Naturwissenschaften*, 1914, Heft. 27.

² *Ext. Annal. Paleont.*, VI, VII and VIII.

³ *Les Grottes de Grimaldi*. Monaco, 1906.

tive figs.). It will, therefore, be recognized that the index is really composite in character, for one can calculate the relationship of the width to the height of the complete rectangle, or to the height of each of the subsidiary rectangles, and this is the plan that has been adopted.

It is to be particularly noted that all the measurements recorded were made on the photographic reproductions. It is essential that this fact should be mentioned, as it is obvious that in a very prognathous skull the nasion-alveolar point height would be decidedly less than the total aggregate of the nasion-akanthion and the akanthion-alveolar heights. In compiling the indices it was decided to follow the plan of estimating the nasal index. The nasal width, which formed the foundation of the whole scheme, was therefore multiplied by 100, the result being then divided by the height of each rectangle in turn.

The second method of estimating the naso-orbito-alveolar index is by means of the author's specially designed Indexometer, of which a brief description will now be given. It possesses the merit of being readily made at home and of being easily applied. All that is required is the possession of two long and four shorter pieces of thin, stout wire, which are arranged in the manner shown in Fig. 1. At each intersection a thinner piece of wire is twisted lightly round both, but sufficiently firm to make the apparatus hold together and yet permit of the horizontal pieces of wire being moved up or down, and the vertical pieces in a lateral direction. I am endeavouring to make arrangements with a scientific instrument maker to manufacture a suitable model of the indexometer which will possess a double sliding joint of the close fitting tubular type at each intersection of the wires.

Mode of Application.—The indexometer is placed against the skull so that the uppermost bar rests against the nasion and the lowermost bar against the alveolar point. The lower ends of the upright wires of course rest upon the table and they require to be slid towards or away from each other, until each lies exactly anterior to the outer border of the nasal aperture. The intermediate horizontal bars are then moved up or down as the case may be until they lie exactly anterior to the lower orbital margins and the akanthion respectively. It is of course clear that the uppermost and lowermost bars are the only ones that are in actual contact with the skull. A little practice enables one to become proficient in the application of the indexometer. The relation of the nasal width to the height of the complete rectangle or to the height of each of the subsidiary rectangles can then be readily estimated, as explained previously.

On investigating the results yielded by this composite index in the male crania of the various racial types enumerated above, it was ascertained that it divided races into two great groups. The first group comprised the European, ancient Egyptian, Hindoo, Chinese, Eskimo, Polynesian, North American Indian, ancient Inca and Patagonian

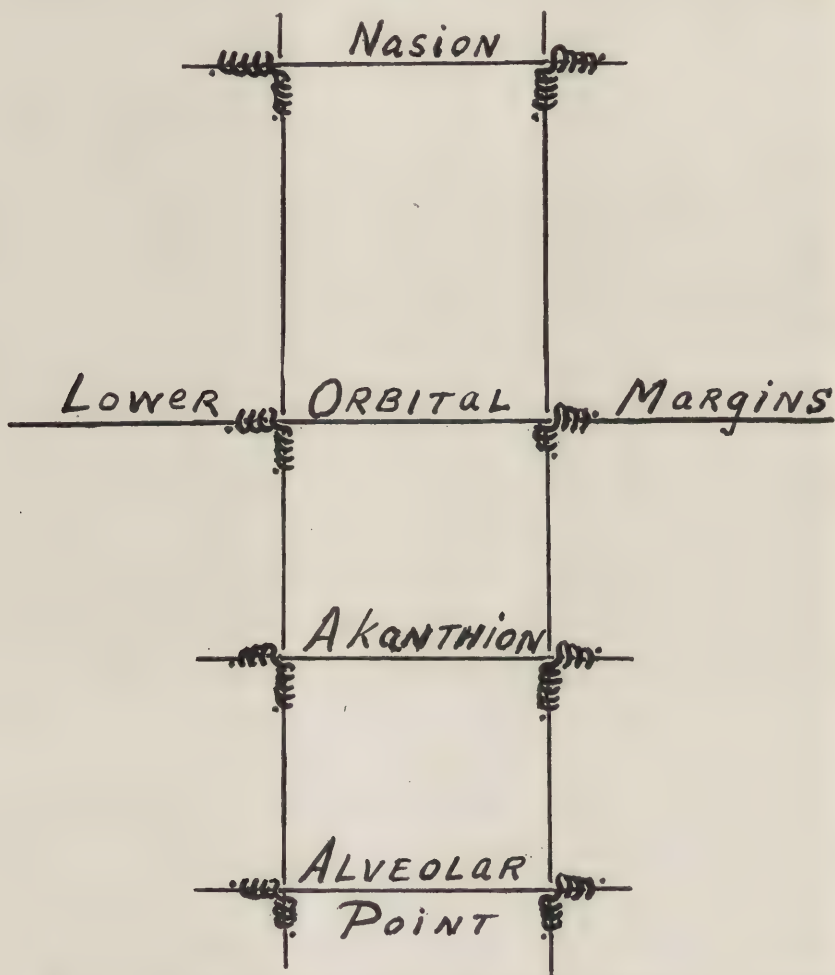


FIG. 1. A sketch of the author's naso-orbito-alveolar Indexometer. It consists of two vertical and four horizontal pieces of stout wire with a double sliding joint at the eight intersections, so as to admit of the horizontal pieces of wire being moved up or down and the vertical pieces in a lateral direction. For its mode of application see the text.

racial types, while the second group, which might be termed the negro group, included the African negro, aboriginal Australian, aboriginal Tasmanian and Melanesian racial types. In the first group the height of the uppermost rectangle was always greater than its width, its index being therefore well under 100, while the two lower rectangles approximated closely to the outlines of squares, their indices being somewhere in the neighbourhood of 100, sometimes above

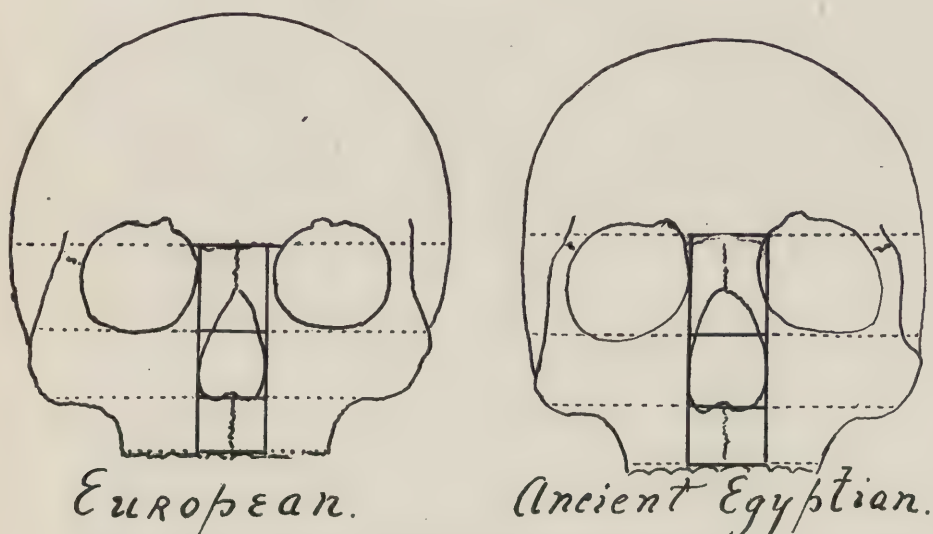


FIG. 2. Represents European and Ancient Egyptian types of skull. It is to be noted how closely the relative proportions of the three horizontal dotted areas of the facial skeleton correspond to each other in these two racial types. It is to be observed further that the two lower rectangles in each case are approximately squares, while the uppermost rectangle is elongated vertically.

and in other cases below. Moreover, the index for the complete rectangle, that is to say, the relation of the nasal width to the nasion-alveolar height, was as a rule under 40. In the Eskimo skull in my collection this index was found to be as low as 31.6 owing to the contraction of the nasal width.

In the second or Negro group, on the other hand, the upper two rectangles approximated to the outlines of squares, their indices being somewhere round 100, while the lowermost rectangle, owing to the great reduction in its height due to the prognathism in these races, exhibited an index of at least 192.5 (African negro), indicating of course that the nasal width was practically twice the height of the

lowermost rectangle. In an aboriginal Australian cranium the index for this rectangle was as high as 252.5. Moreover, the index for the complete rectangle in these races was always well over 40, that is to say, the nasal width was in all cases more than 40 per cent of the naso-alveolar height. In an aboriginal Australian skull it was as high as 50.7 per cent. It is therefore manifest that this index demarcated races into two definite groups,¹ the appearance exhibited by the various rectangles being illustrated in Figs. 2, 3, 4 and 5.

In Fig. 2 European and ancient Egyptian types of skull have been placed side by side in order to demonstrate how closely the relative proportions of the three horizontal areas of the facial skeleton correspond in these two racial types. Note further that the two lower rectangles in each case are approximately squares, with indices therefore in the vicinity of 100, while the uppermost rectangle is elongated vertically, with an index well under 100 in both crania. The writer has previously referred more than once² to the high type of index that is exhibited in some ancient Egyptian skulls, and is therefore not surprised to find that the naso-orbito-alveolar index consistently follows these, and brings the two racial types into some degree of approximation.

I have placed the Mongolian, Polynesian and Eskimo types together in Fig. 3. It will be observed once more that the relative proportions of the three horizontal areas of the face and the outlines of the three rectangles correspond more or less closely to those in Fig. 2, except in the case of the Chinese cranium. I utilized the latter deliberately as an example of variation, since two other skulls of this race that I examined showed relative proportions of the three rectangles that conformed to the European-Asiatic type. This variation is due to the varying levels of the lower orbital margins which would of course affect the relative proportions of the uppermost and intermediate rectangles. The degree of variation of the naso-orbito-alveolar index cannot of course be fully worked out until a large series of crania has been examined. In the meantime I will have to rest satisfied with the demonstration and mode of application of the index.

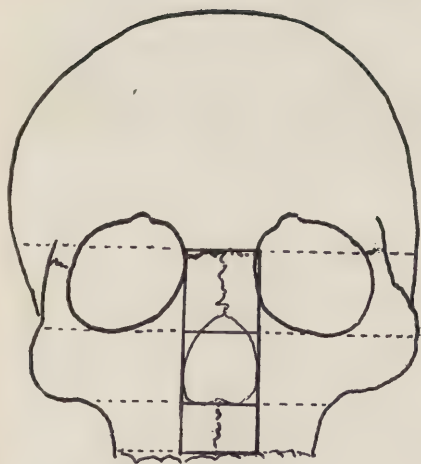
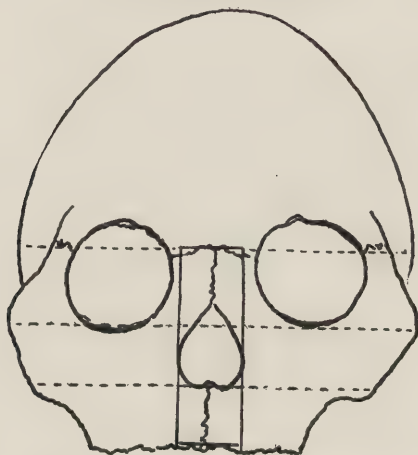
I had difficulty in deciding where to place the Eskimo skull in the illustrative Figs. for this paper. As he has some Mongolian attributes,

¹ The zone of demarcation between these groups would become greatly reduced in an extensive series of crania.

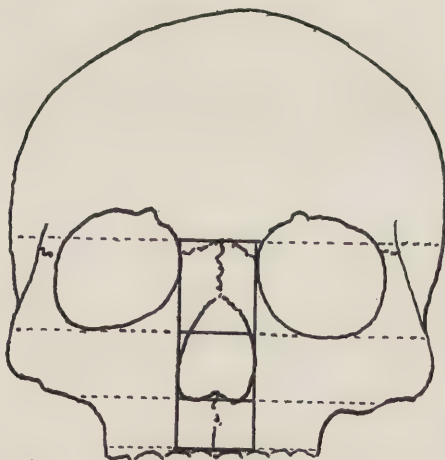
² Manchester University Museum Publication, No. 68, 1910; also *Trans. Nova Scotian Inst. Sci.*, XIV, Pt. 1, 1916.

I placed him with the Chinese and Polynesian crania. Owing to his contracted nasal aperture, however, he occupies a definitely isolated plane, and I have therefore installed him in the upper part of Fig. 3 by himself.

Eskimo



Chinese.



Sandwich Islander.

FIG. 3. Shows Chinese, Polynesian and Eskimo types of skull. The rectangles of the Eskimo and Polynesian types of crania correspond more or less to those depicted in Fig. 2. The Chinese cranium has been utilized to demonstrate the fact that the naso-orbito-alveolar index has a considerable range of variation.

Representatives of three aboriginal races of the Western Hemisphere have been chosen for Fig. 4, which demonstrates that the relative proportions both of the three horizontal dotted areas of the facial

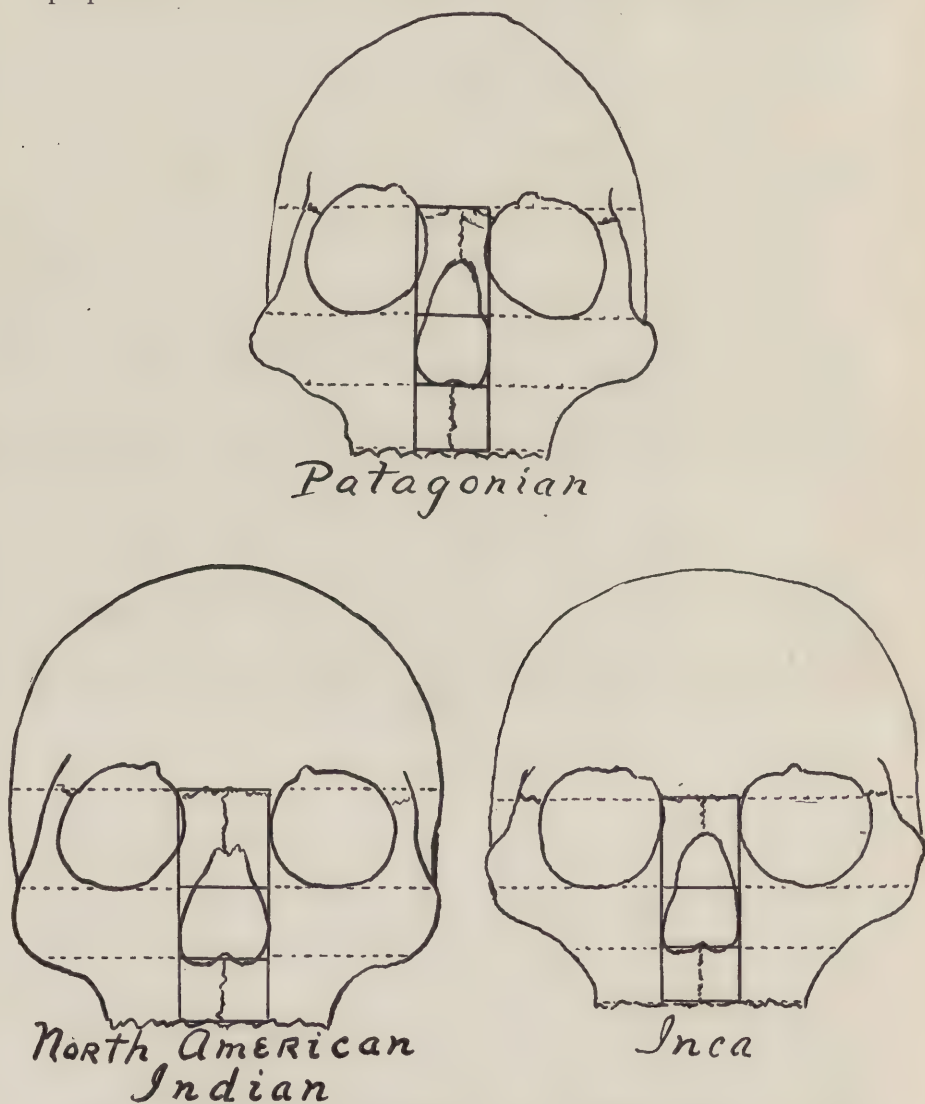


FIG. 4. Representation of the crania of three aboriginal races of the Western Hemisphere. There is a certain degree of correspondence in the relative heights of the three rectangles, which makes them conform more or less to the European-Asiatic type. The nasion-alveolar height of the Patagonian skull is an unusual feature, though apparently not a definite character of this race.

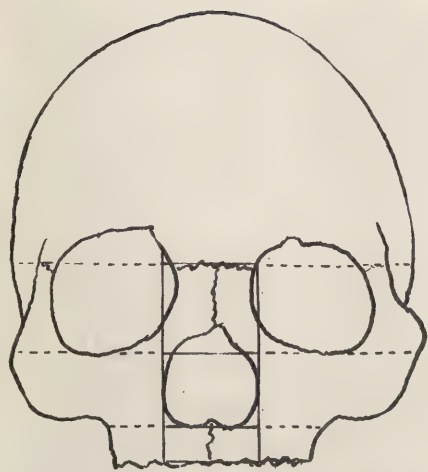
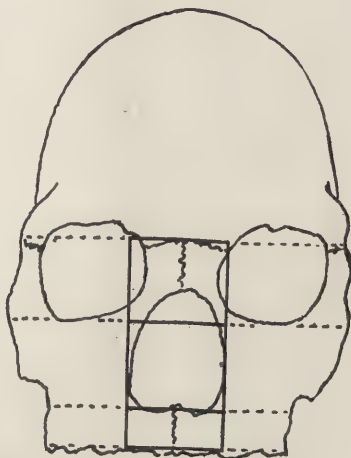
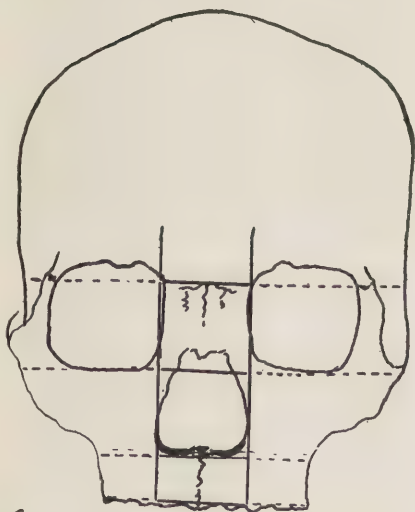
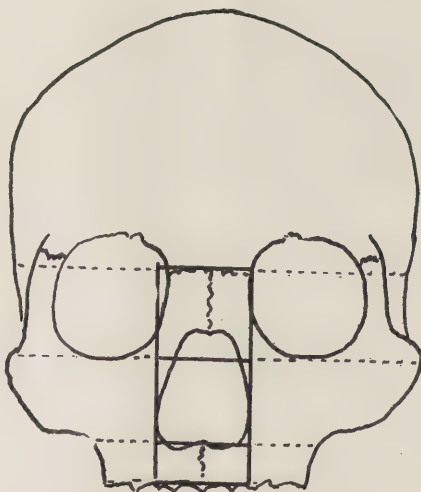
*African Negro**Aboriginal Australian**Aboriginal Tasmanian**Melanesian*

FIG. 5. Shows that African negro, aboriginal Tasmanian, aboriginal Australian and Melanesian types of skulls give corresponding results when studied by means of this index. The two upper rectangles are approximately squares, while the lower-most show an extreme degree of reduction of their heights, due of course to the prognathism in these races. These crania thus display a marked contrast to those of the Euro-Asiatic type.

skeleton and of the three rectangles conform more or less to the general European-Asiatic form, or what might be termed the Eurasiatic type. I was much struck by the amount of the nasion-alveolar point height in the Patagonian skull. An examination of this cranial group in the Royal College of Surgeons Museum, however, demonstrated the fact that this did not appear to be a characteristic racial feature.

The inter-racial range of variation in the relative sizes of the three rectangles was such that the Eurasiatic races, the Polynesians and the aborigines of the Western Hemisphere were practically on the same level. Thus it appears as if the Eurasiatic types could be linked by this craniometric method with both the American Aborigines and the Polynesians. In a previous communication¹ the writer has referred to the fact that the crania of the aborigines of the Western Hemisphere betray some Mongoloid affinities, and a link with the yellow-brown Mongol of Asia is also provided by the Polynesians of the Pacific. In reference to this fact it is important to quote Hrdlička's remarks on p. 183 of Bulletin No. 52 of the Bureau of American Ethnology²: "This general American type is more or less related to that of the yellow-brown peoples, wherever these are found without decided admixture with other strains. These yellow-brown people, including the American, represent one great stream of humanity."

Fig. 5 demonstrates the fact that the naso-orbito-alveolar index placed the African negro, the aboriginal Tasmanian, the aboriginal Australian and the Melanesian on the same plane. It is interesting to note how the uppermost and intermediate rectangles approximate in all four cases to the outlines of squares, and are therefore about equal in size, their indices being somewhere in the vicinity of 100. The great feature of Fig. 5 is, however, the great reduction in the height of the lowermost rectangle, due, as previously explained, to the high degree of prognathism in these races. The index for it was therefore about 200 or even much more (192.5 in the African negro, 199.9 in the aboriginal Tasmanian, 234.5 in the Melanesian and as high as 252.5 in an aboriginal Australian), indicating of course that its height was about one half its breadth—in some cases much less.

THE CRANIA OF FOSSIL HOMINIDÆ

On comparing Fig. 5 with Fig. 6, it is evident that the cranium of the Grimaldi youth exhibited fairly consistently the characteristics of

¹ *Trans. Nova Scotian Instit. Sci.*, Vol. XV, Pt. 1, 1919.

² *Early Man in South America*, 8°, 1912. See also his "Genesis of The American Indian," *Proc. XIX Intern. Cong. Amer.*, Wash., 1917.

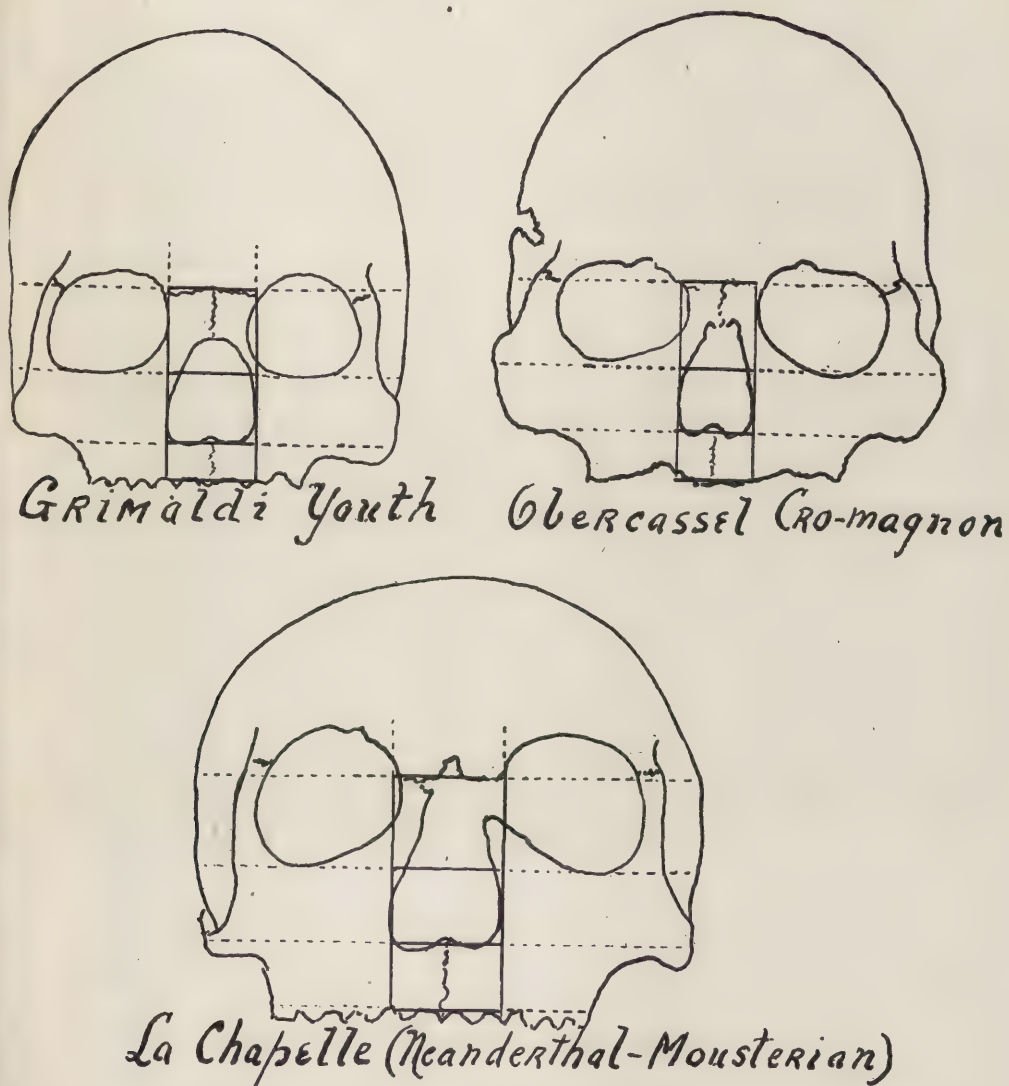


FIG. 6. Tracings of the Grimaldi skull (Verneau), the Obercassel skull (Bonnet), and the La Chapelle cranium (Boule).

The Grimaldi skull shows the Negro type index. In the Obercassel specimen the index conforms fairly with that of the Euro-Asiatic type. The Cro-Magnon race represents the only example of fossil Hominidæ amongst those examined that could with safety be placed in the Eurasiatic category. In the La Chapelle skull it will be observed that the three rectangles are quite different from those of the racial types represented in Figs. 2 to 5.

the negro naso-orbito-alveolar index. He could therefore be definitely placed in his appropriate racial position. The indices for the uppermost and intermediate rectangles of his skull were approximately 100, while that for his lowermost rectangle was found to be as high as 233.3—that is to say, practically the same as that for the modern Melanesian skull cited in the preceding paragraph.

The skulls of the Obercassel Cro-magnon man (Fig. 6b) and of the "old man" of Cro-magnon, were the only cranial types of fossil Hominidæ amongst those examined that could be safely placed in the Eurasiatic category. A study of Fig. 6b will demonstrate the fact that the relative proportions of the three horizontal dotted areas of the Obercassel facial skeleton conform more or less to those of the general European-Asiatic type, while the indices for the three rectangles likewise consistently follow this result.

The application of the naso-orbito-alveolar index to the La Chapelle and Gibraltar crania, representing Neanderthal-Mousterian man, provided some interesting results. The great nasal width of these two crania seemed at first sight to render them comparable, to those of the modern negro type, but the height of the lowermost rectangle in both instances at once negated this impression (Fig. 6c). On examining this figure it will be noted that the three horizontal dotted areas of the La Chapelle skull were almost equal in height, which rendered it quite different from the modern European-Asiatic type or the modern negro type. Moreover the three rectangles were also quite different from those of the modern racial types, for all three were approximately equal in size and were transversely elongated owing to the great nasal width. It is thus clear that the Neanderthal-Mousterian type of skull is one that does not exist at the present day.

ENUMERATION OF THE VARIOUS MODES OF APPLICATION OF THE NASO-ORBITO-ALVEOLAR INDEX

1. Calculate the relation of the nasal width to the height of the complete rectangle, that is to say, the relation of the nasal width to the nasion-alveolar height.
2. Calculate the relation of the nasal width to the height of each of the three subsidiary rectangles.
3. Calculate the relation of the square area of the three subsidiary rectangles to each other. For this investigation the crania would all have to be photographed to the same scale of reduction.
4. The relative proportions of the three horizontal areas of the

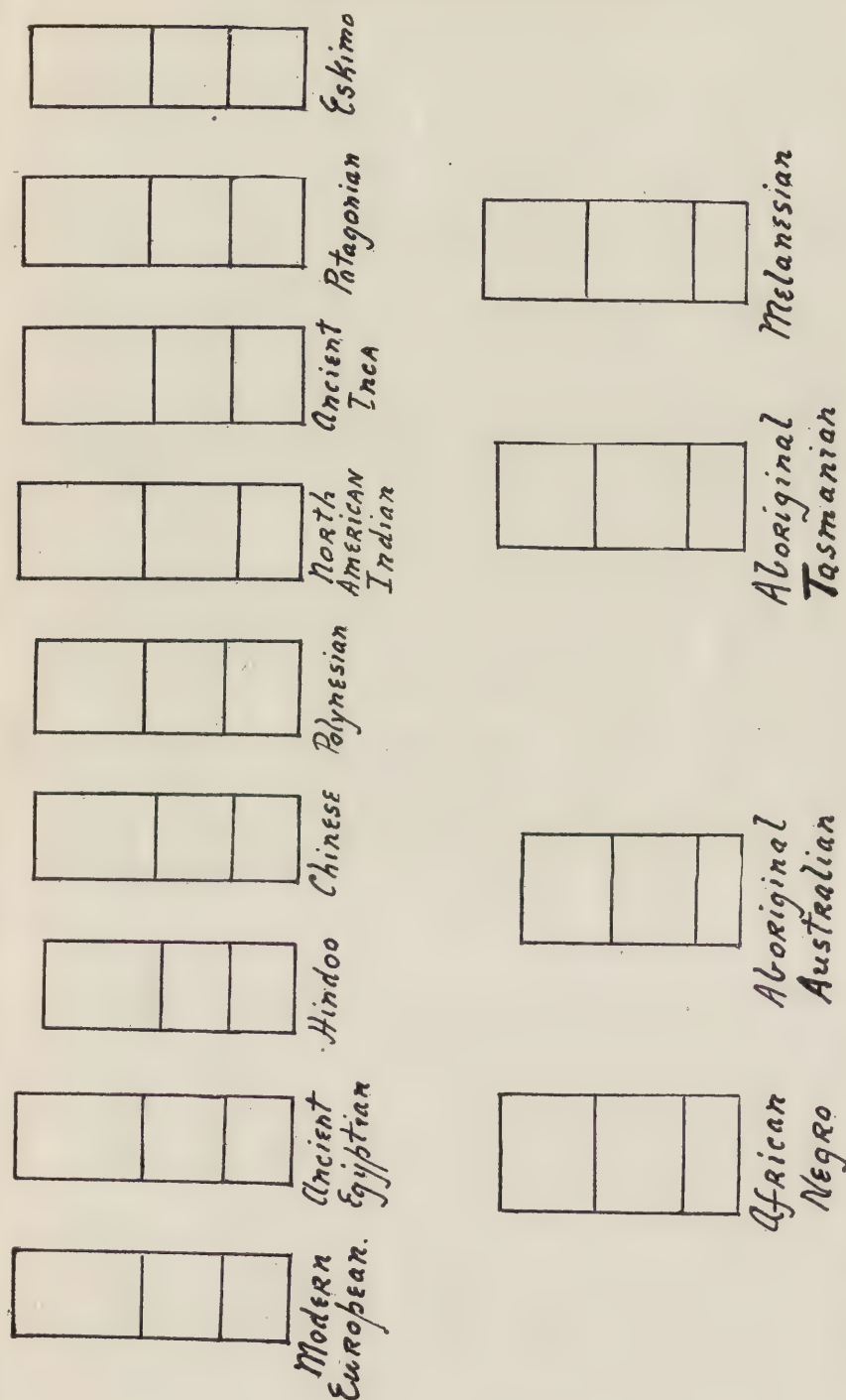


FIG. 7. The naso-orbito-alveolar method is seen to divide races into two distinct groups. The skulls were all reduced to the same size approximately.

facial skeleton mapped out in Figs. 2 to 6 could be studied. This investigation might be regarded as accessory to the estimation of the naso-orbito-alveolar index, and so far as I have been enabled to determine, promises to provide a new and fruitful field of research.

In concluding this paper which is to be regarded entirely as a preliminary announcement owing to the comparatively small series of crania examined, and the vast issues that have been introduced, I wish to emphasize the fact that all the conclusions arrived at have been based entirely on this one "naso-orbito-alveolar" craniometric method. It is quite obvious that one cannot depend upon it alone as a means of classifying mankind. Still, its value as a further means of studying the cranium appears to present certain possibilities. Another reason for this publication is that it may stimulate further study of the comparatively neglected *norma frontalis* of the skull.

ASPECTS OF THE SKULL: HOW SHALL THEY BE REPRESENTED?

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One of the chief handicaps of physical anthropology has been hitherto lack of unity in mode of procedure. This is particularly true of anthropometry and osteometry. In order that the records of each observer may be readily made use of by every other observer, it is imperative that series of measures be uniform and be taken in uniform ways.

Many authors have contributed to our knowledge of these subjects. Under the leadership of Broca, the French developed a method that has had a very wide influence. In the so-called Frankfort Agreement, German anthropologists took an important step in the direction of unification. It remained, however, for the International Congress of Prehistoric Anthropology and Archeology held at Monaco in 1906 to place the matter of unification on an international basis.

At Monaco the International Commission agreed upon twenty-four measures of the cranium, eight of the lower jaw, and twenty-one of the head. At the next session of the Congress held in Geneva in 1912, a reconstituted International Commission agreed upon forty-nine additional measures of the living subject.

It also adopted a technique for the reconstruction of the height by the aid of the long bones; and passed a resolution that for the graphic representation of skulls, anthropologists employ the horizontal plane either of Broca or of the Frankfort Agreement.

There remain for consideration at some future Congress measures of the skeleton in general, exclusive of the cranium and lower jaw.

There is another matter which it seems to me might well engage the attention of some future international commission; namely, an agreement as to what *attitudes* to give the skull in representing its five aspects: *norma frontalis*, *lateralis*, *occipitalis*, *verticalis*, and *basilaris*.

For the front view of the cranium there is but one logical attitude; namely, the vertex up. With this there is already universal agree-

ment in practice. The same may be said of the rear or occipital aspect.

For the lateral aspect, while the rule of vertex up is universally followed, the skull may be and is made to face to the left or to the right—to show either its left side, or its right side. Would it not be well to agree as to which of these two attitudes is preferable? The writer proposes that the left side be chosen for two reasons. In the first place, in paired measures it is already the rule to take the measures on the left side; in the second place, by making the skull face to the left is to follow the rule of the printed page, which one reads from left to right; and finally this position gives us a more natural position of the teeth. Exceptions to this proposed rule might justly be claimed in cases where one wished to present some special feature which occurred on the right side only.

The problem of choosing the correct attitude for the top or vertical view is still more complicated. There are four possible attitudes: face up, face down, face to the left, and face to the right. In all four positions the vertical axis would of course be at right angles to whichever of the two horizontal planes one might select. Since to all intents and purposes, the skull has bilateral symmetry, both sides should be given an equal chance for self-expression. This can be accomplished only by preserving the bilateral integrity of the figure; in other words, by placing the face either up or down.

Is there a choice between these two attitudes?

Most certainly there is. The face is the front and should be first. The position of the first is at the top not at the bottom. Therefore, in the *norma verticalis* of the cranium, the face should be at the top. There are, moreover, two other valid reasons for selecting this attitude. It brings the right side of the skull on the right side of the page and the left side on the left. In the second place, the cranium gives the appearance of being in more nearly stable equilibrium when resting on the occipital bone than when resting on the nose, the alveolar margin, or even on the brow ridge. The correct attitude for the *norma verticalis* then is face up.

What do we find in actual practice? Authors have made use of all four possible attitudes at random, sometimes employing more than one attitude in the same work. As a rule, however, after choosing a given attitude, the author sticks to it throughout the publication. Thus Broca (*Instructions Craniologiques*), R. Virchow (*Crania Ethnica Americana*), de Quatrefages and Hamy (*Crania Ethnica*), Topinard,

Sir William Flower (*J. A. I.*, X, 157, 1880), Harrison Allen, Martin, and Hrdlička, to mention only a few authors, place the face down. On the other hand, in at least certain works of Sir William Turner (*Challenger Reports*), W. L. H. Duckworth (*Anthropology and Morphology*), Eugene Pittard (*Crania Helvetica*), Rivet, E. A. Spitzka, and A. Keith the face-up attitude of the vertical aspect is chosen. These two lists are sufficiently long to show the need for unification.

Once the attitude for the *norma verticalis* is agreed upon, it should not be difficult to unite upon the correct attitude for the basal aspect of the cranium; for if the face-up attitude is correct in the one case, it must be also in the other case. Here again the practice has been as divergent as it was in respect to the vertical aspect. Those who choose the face-up attitude for the latter are generally consistent and place the *norma basilaris* face up also, and vice versa. On the other hand, some authors are not even consistent, but alternate between the two attitudes.

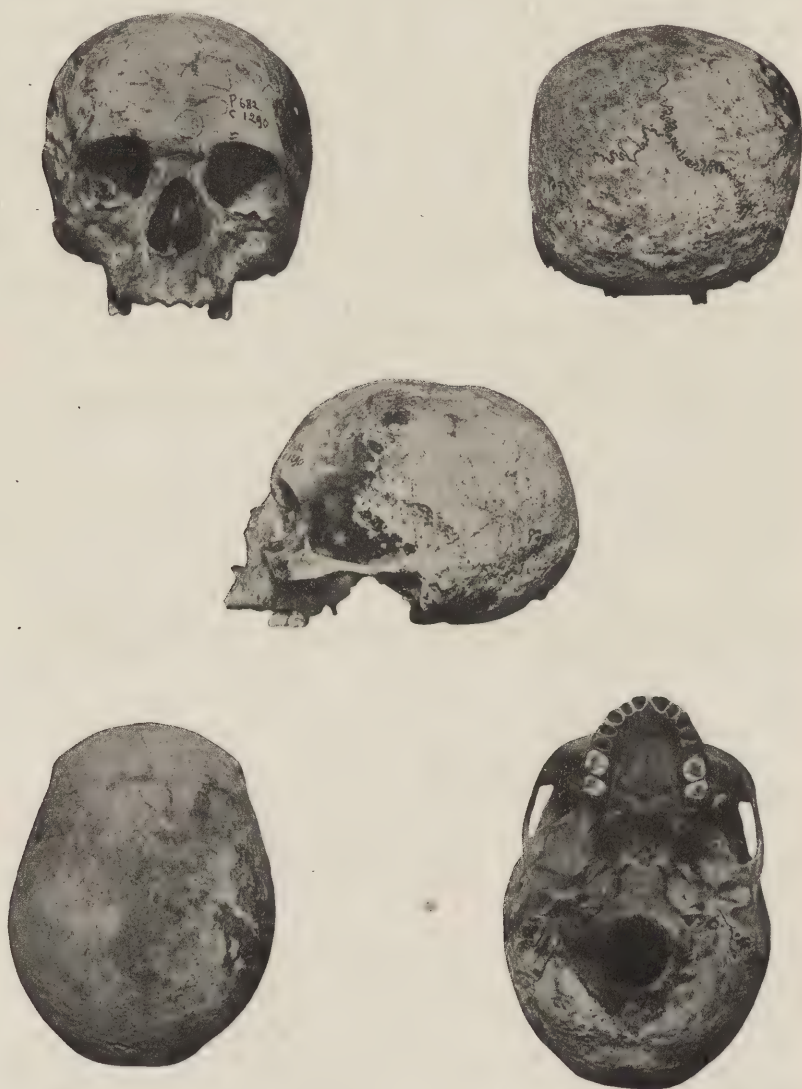
Having fixed upon the face-up attitude for both the vertical and basal aspects of the cranium, it follows naturally that in illustrating crania sectioned transversely the same attitude should be employed, no matter whether one is viewing the floor or the vault of the endocranium. Here again in practice there is both inconsistency and diversity. For example, for the vertical and basal aspects of the cranium as a whole, Broca turns the face down (incorrect), but in his illustration of the floor of the endocranium the face is turned up (correct). In the *Handatlas* of His and Spalteholz, the face is turned up (correct) in the figure of the floor of the endocranium, while in that of the vault of the endocranium it is turned down (incorrect and inconsistent). In this work both the *norma verticalis* and the *norma basilaris* of the entire cranium are correct (face up).

It often happens that a basal view (hard palate) of the upper jaw alone is wanted. In such a case, there should be no hesitancy in selecting the same attitude it would have if attached to the cranium; namely, the face-up attitude, which happens to be the one suggesting the more stable equilibrium. Notwithstanding, some authors do just the opposite thing, especially those who are in the habit of turning the cranium face down.

What is true of the upper maxilla is likewise true of the lower jaw. It should be represented in the same position it would have if in natural contact with the cranium. It should rest on the condyles and angles

with the chin (symphysis) up for both the basal and the alveolar aspect. With its lateral aspect, chin to the left would take precedence over chin to the right.

That which is good form for the brain case is also good form for



THE FIVE ASPECTS OF A SKULL FROM THE RHÔNE VALLEY, SWITZERLAND. Horizontal plane of Broca. (After Eugene Pittard.)

the brain. It should be allowed to assume the same attitudes it would have if kept unmolested in the cranium.

For the skull as well as the brain, or even the dissected head, a simple rule of procedure may be expressed as follows: *Vertex up, face to the left, face or front up.*

If this rule is a good one for anthropologists to follow, there is no valid reason why it should not be followed likewise by zoologists and paleontologists, especially where the requirements are similar to those in man.

In respect to the rest of the skeleton, the same general rule should hold. If so, then there is need of unification of practice both past and present.

In so far at least as the genus *Homo* is concerned, this would mean that segments of the skeleton or disarticulated bones should be represented in the attitude they would have if articulated, that is to say, in their normal position in life. The clavicle would thus be represented in a horizontal position, limb bones in a vertical position. If any other than a superior-surface-up attitude is required for a vertebra, for example, it should be represented with the anterior aspect up and the posterior aspect down, no matter whether the view be from above or from below. Or if a segment including vertebra, ribs, and sternal junction be represented, the ventral or front portion should be up and the dorsal down.

When it comes to the hands and feet, valid arguments may be adduced for two opposite attitudes. It might be well, therefore, to employ each under given conditions. When the hand or foot bones are shown in connection with the lower arm or leg bones, let the phalanges point downward. This would be in conformity with a previously formulated general rule. On the other hand, if the articulated bones of the foot alone be shown, let it be with the toes up and the heel down, both for the sole aspect and the reverse. This would be following the rule that the front should take precedence over the back. The same attitude might well be chosen for the articulated bones of the hand alone; since this would be in conformity with the attitude selected for the articulated foot bones and would have the added advantage of making it possible for an observer to orient his own hand with the figures on the printed page, thus immensely facilitating comparison and observation.

MULTIPLE BIRTHS AMONG THE CHINESE

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INTRODUCTION

The Chinese Annals contain not only records of human events, but also of unusual natural phenomena which left a deep impression upon the minds of the contemporaries. In the early days of historiography, when occurrences were chronicled day by day and year by year, the two categories of human and natural events were noted indiscriminately, merely in the chronological succession as they happened. In the introduction to the Shu king we read, for instance, "The king's uncle, the prince of T'ang, found a head of grain, two stalks in different plots of ground growing into one ear, and presented it to the king." In the Bamboo Annals (*Chu shu ki nien*) this feature is still more conspicuous: solar eclipses, meteoric falls, earthquakes, droughts, extraordinary phenomena in the growth of trees, appearance of a fung-hwang (so-called phoenix), rain of particles of earth, unusual thunderstorms, and other phenomena are there on record, being interspersed with the record of imperial and military affairs. Beginning from the Annals of the Former Han Dynasty (*Ts'ien Han shu*), a novel departure from the old practice was instituted in as much as the natural events were detached from the general narrative to be relegated to a special section, entitled "Records relating to the Five Elements" (*Wu hing chi*). The majority of official annals has adopted this practice. These chapters contain most interesting information, not for the historian, but for the scientist, and therefore merit close study. They give detailed lists, with exact reference to date and place, of great catastrophes, such as famines, droughts, locust-pests, inundations, hail-storms, landslides, earthquakes, conflagrations, excessive cold, electric storms in the winter, etc., abnormal phenomena and monstrosities in domestic animals and human beings, cases of insanity, abnormal customs and practises, etc. It is to this department of records that we owe our principal information on a subject which has not yet been discussed,—the frequency of multiple births among the Chinese.

In ancient times, under the Chou dynasty, the officer presiding over the people (*se min*) was obliged to keep a register of the population. All individuals were recorded from the age when the teeth appear. A separate count was taken of males and females; every year, the number of births was added, while the number of dead was taken off the register (cf. E. Biot, *Le Tcheou-li*, Vol. II, p. 353). We cannot but regret that documents of this character have not survived. No allusion to twins or other plural births is made at that period.

The chapters *Wu hing chi* of the two Han Annals contain no records of multiple births. The *Wei shu* gives a single case of a quadruplet birth. Triplets, but only two cases, are first recorded in the Books of the Tang Dynasty, and there is a long list of them under the following Sung dynasty. There is one case of triplets of early date, not on record in the Annals, but in the *Sou shen ki*, written by Yü Pao in the early part of the fourth century, who reports that "in A.D. 243 there was a woman who gave birth to three sons." I have not embodied this case in my statistical review of the matter, as the work in question is a Taoist book of marvels, and as the extant edition presents merely a retrospective make-up (cf. Wylie, *Notes on Chinese Literature*, p. 192).

While triplet and quadruplet births are mentioned in the Annals with comparative frequency, they hardly trouble about twins, save a few cases of united twins. This omission may indicate one of two possibilities: either twin-births were too common to attract much attention, or were too rare to be worthy of notice. This alternative cannot be decided without a solid foundation of statistical material, which unfortunately we do not have. At the outset I am not disposed to assume, on a merely empirical basis, a high degree of fecundity of the Chinese woman or a relative frequency of twins; for it is a common experience of our time that personal opinions and impressions along this line are seldom, if ever, upheld by the results of statistical research. Restraint in this case is the more commendable, as in regard to twin-births in Annam we have the following observation of Dr. A.-T. Mondière ("Monographie de la femme annamite," *Mémoires de la Société d'anthropologie*, II, 1875, p. 474): "Les grossesses doubles sont excessivement rares chez la femme annamite. Sur les 153174 naissances que j'ai relevées sur les cahiers des villages de toute la Cochinchine de 1872 à 1877 inclus, je n'ai trouvé que 15 accouchements de jumeaux. Soit 1 sur 10211 naissances. De plus, un arrondissement particulier, celui de Bentré, semble avoir ce privilège,

car sur 15 accouchements gémellaires il en a 9 à lui seul, c'est-à-dire 60 pour 100. Les six autres arrondissements (sur 19) qui en ont présenté: Bien-hoà, Chau-Doc, Saigon, Soctrang, Tan-an, Tay-ninh, n'en ont eu chacun qu'un seul cas, en ces six années. D'après ce que les autorités cambodgiennes m'ont déclaré, les jumeaux seraient plus fréquents chez eux, et d'une façon assez sensible, mais ils n'ont pu me fournir de chiffre exact."

A real investigation of the problem in question is impossible for the present, as we lack any vital statistics for the Chinese Republic. Nevertheless I venture to hope that the facts and observations given below will be of some interest to anthropologists. In order to critically balance the data furnished by the Chinese Annals, it would be indispensable to have reliable birth statistics for China, to know the birth-rate for the different provinces, and to depend on good records showing the total number of plural births for at least a decade. In default of such material in the mother-country I anticipated to receive at least some data from those countries outside of China with a large Chinese population, although it must be taken into account that social and economic conditions of the Chinese abroad are different and that, above all, Chinese emigrants hardly ever take their families along, but intermarry, when settled, with women of other nationalities. I have not yet been able to obtain relevant statistics from the British, French and Dutch colonies; but what I have found thus far is not very encouraging. The Birth Statistics for the Registration Area of the United States for 1915 (Washington, 1917) give a total of 74 births (33 males and 41 females) among the Chinese for that year, but nought else.

According to a communication of Dr. William H. Davis, chief statistician in the Bureau of Census, Washington, D. C., there were, in the years 1915-17, 309 births among the Chinese in the registration area for births in the United States (California not being admitted to the registration area is not included), only one pair of twins appearing in this total. The State of California gives in its vital statistics only the number of births and deaths of its Chinese populace, without touching the question of plural births. In 1916 there were 425 births (compared with 727 cases of death); in 1917, 419 births (compared with 818 cases of death) among the Chinese of California (Twenty-Fifth Biennial Report of the State Board of Health of California for the Fiscal Years from July 1, 1916, to June 30, 1918, Sacramento, 1918, pp. 201, 203, 205, 207, 224). The statistics of Mexico contain merely

the number of Chinese living in the various provinces, the total, as taken in the third and last census of 1910, being 13,118 men and 85 women = 13,203 (Estados Unidos Mexicanos, *Boletín de la Dirección General de Estadística*, Num. 5, p. 37, Mexico, 1914), but no tables of births.

A literal translation of all cases of triplet and quadruplet births, as they are chronicled in the Annals, has been prepared by me. In every case, the exact date, the name of the family, the social status of the father, and the place where he lived are given; also the distribution of sex in each birth is indicated. As this material would be unintelligible without the use of Chinese characters, it is here omitted. Readers interested in this phase of the work may be referred to the New China Review of Shanghai, in which the complete article will be published. For some of the bibliographical references mentioned on the following pages I am under obligation to Dr. A. Hrdlička, Curator of Physical Anthropology in the U. S. National Museum of Washington.

UNITED TWINS

The Chinese Annals have preserved a few cases of twins grown together at birth. In this case, the question naturally is of twins produced from a single ovum.

In the fourth year of the period Kien-hing (A.D. 316), under the Emperor Min of the Tsin dynasty, a woman of the family Hu, when she was at the age of twenty-five, the wife of Jen Kiao, a minor official (clerk) in the district of Sin-ts'ai (prefecture of Ju-ning, Honan), gave birth to female twins grown together in the region of the abdomen and the heart, but separated above the breast and beneath the navel.—*Sung shu*, Ch. 34, p. 28.

In A.D. 487 (under the Emperor Wu of the Ts'i dynasty), the wife of Wu Hiu, one of the people of Tung-ts'ien in Wu-hing (now Hu-chou fu, Che-kiang) gave birth to male twins grown together below the chest down to above the navel.—*Nan Ts'i shu*, Ch. 19, p. 16b.

In the fourth month of the third year of the period Yi-fung (A.D. 678), King-chou (Kan-su) presented the Court with two infants the hearts of which were connected, but each with a separate body. Formerly it had happened that the wife, née Wu, of Hu Wan-nien, a soldier of the guard in the district Shun-ku (Kan-su), gave birth to twins, a male and a female, whose breasts were connected, but who, for the rest, had individual bodies; when separated, both died. At a subsequent birth it was thus again. The twins were boys, and were

brought up. In the above mentioned year they had reached the age of four years, and were presented to the Court.—*T'ang shu*, Ch. 36, p. 21.

• In A.D. 1610, the wife of Li Yi-ch'en of Fan-ki (in Tai-chou, Shan-si), née Niu, brought forth two girls with their heads and faces grown together, but with separate arms and legs.—*Shan-si t'ung chi* ("Gazetteer of Shan-si Province").

Two Chinese twins grown together, born in 1887, were shown by Barnum and Bailey in 1902, and at that time were still unseparated and well. Cf. R. Virchow, *Xiphodymie* (*Z. Ethn.*, 1891, pp. 366-370).

The modern Gazetteers occasionally record the birth of twins, not, however, on account of any special interest attached to the fact itself, but merely in order to emphasize the interest in the vitality of twins (cf. W. A. Macnaughton, *The Longevity of Twins*, *Caledon. M. J.*, X, pp. 127-129, Glasgow, 1915). The following examples from the Gazetteer of Hwa-yang (*Hwa-yang hien chi*, Ch. 43, p. 4) will suffice to illustrate this feature.

The wife of Chu Ch'ang-hwa, née Lin, had 14 sons, among these 2 pairs of twins, who did not die prematurely, but are still alive.

The wife of Chung Se-kin, née Tsou, had 9 sons, among these one pair of twins still alive.

The wife of Chung Chao-k'in, née Chang, had 9 sons, among these one pair of twins still alive.

The wife of Li Ch'ao-kung, née Lin, had 8 sons, among these one pair of twins still alive.

TRIPLETS

Following is a summary of the Chinese data. For the period of the T'ang dynasty (A.D. 618-906) only two cases of a triplet birth are on record in the Annals. In A.D. 775 a woman of the family Chang gave birth to one male and two females, and in A.D. 905 triplets (males) were born by the wife of P'eng Wen, one of the people of Ju-yin in Ying-chou (Ngan-hwi or An-hwi Province). For the Sung period the data of triplet births are fuller than for any other dynasty. From A.D. 960 down to A.D. 1150 we have a total of 110 cases, listed with exact dates, family and place names, father's social status, and sex distribution in each triplet birth. For the time from A.D. 1023 to 1126 no list of names is given, but merely a statistical record which covers several reign-periods of emperors. It is here reproduced in tabular form.

RECORDS OF MULTIPLE BIRTHS IN CHINA, 1023-1126

Period	Years	Quadruplets (Males)	Quadruplets (3 Males, 1 Female)	Triplets (Males)	Triplets (2 Males, 1 Female)	Total
1023-68.....	46	2	—	44	1	47
1068-83.....	15	1	1	84	—	86
1084-99.....	16	2	—	18	1	21
1100-26.....	27	1	—	19	—	20
Total.....	104	6	1	165	2	174
		Quadruplets total 7		Triplets total 167		

While the preceding cases are not recorded in the way of vital statistics, but solely as unusual events, the above table conveys the impression of embracing a fairly accurate register of all multiple births (save twin births), which took place within the span of a century. The proportion of quadruplet to triplet births in this period is 1: 23.86. The total of triplet births on record during the Sung epoch, accordingly, is $110 + 167 = 277$. The total of quadruplet births during the same period is 7 (as shown by the above table) + 7 (recorded in the following section) = 14. The proportion of quadruplet to triplet births for the entire period of the Sung is 1:19.78; while the proportion for the entire period of Chinese history here considered (473-1643) is 1:10.8. This calculation is based on a total of 324 triplets and 30 quadruplets.

There are no multiple births on record in the chapter *Wu hing chi* of the *Kin shi*. The *Yüan shi* (Chs. 50-51), covering the period from 1260 to 1367, contains only 15 cases of triplets (all males), recorded under the years 1261, 1265, 1273, 1285, 1291, 1297, 1300, 1327, 1328, 1335, and 1363. In the years 1273, 1297, 1335, and 1363, two cases are listed for each year; and it is of especial interest that in two instances we have two cases of triplets in the same family, the interval between the two being in either case given as three years. According to Dr. Puech, to whom we owe excellent studies on the causes of multiple births, the more children a woman has had at close intervals, the more she will be inclined toward these physiological anomalies. Three women admitted in the St. Petersburg Midwives' Institute between 1845-59 in their fifteenth pregnancy had triplets, and each had triplets three times in succession (J. M. Duncan, *Fecundity*, p. 71).

For the period of the Ming dynasty (1368-1643) we lack official records; but the section *jen i* of the *T'u shu tsi ch'eng* gives a list of 30 cases of triplet births, extracted from the provincial and local Gazetteers, and covering a period from 1404 to 1626. In 1413, 1515, and

1520, two cases are recorded in each year. In view of the fact that this material is extracted from a number of scattered books, it cannot lay claim to completeness; the figure 30 is certainly much removed from reality, but even if multiplied by 3 or 4, it is left far behind the total of the Sung period. On the whole, the impression prevails that the number of multiple births has steadily been on the decrease from the days of the Sung. This would agree with an anthropological theory to the effect that the phenomenon of multiple births in man represents a survival of or reversal to his former animal state and that with the advance of civilization the number of such births is liable to decline. There is a correct biological viewpoint in this hypothesis, but it does not account for all facts connected with the phenomenon, and, above all, conflicts with given data and statistics. It is not brought out by the vital statistics of any European country that the frequency of plural births is on the decline; on the contrary, in France, for instance, it is surprisingly high (see below). Further, if that theory were correct, we should naturally anticipate to find the greatest number of multiple births among primitive tribes, which for all we know is not the case. Hardly a century has elapsed that records of plural births have been taken in Europe, and this period is too short to allow us to indulge in much speculation on the subject.

According to the Statutes of the Manchu Dynasty, it was decreed in 1663 that in the case of a triplet birth or a twin birth of a boy and a girl, if it should occur among the people of the Eight Banners, a special report should be submitted to the Board of Rites; if it should occur in the provinces, the governor of such province should report to the Board of Rites, which would have to forward it to the Board of Finance, the latter to grant a premium of five piculs of rice and ten pieces of cloth. In 1674 it was ordered that a special report should be made solely in the case of male triplets, but not in the case of twins or female triplets. In 1684 an edict ordained that in the case of male triplets the Board of Rites and the Board of Finance should submit a joined report to the Throne, and that rewards should be authorized in accordance with law. This benevolent attitude toward the energetic propagators of the race was not an innovation of the Manchu, but a heritage of the Ming; for under the Ming we are frequently informed of special grants of food, cloth, and even paper money, made to these involuntary heroes from public funds.

It may hence be inferred that under the Manchu régime a register of male triplets was kept, and presumably is still preserved in the

archives of Peking. If it should ever be published, the fact must be borne in mind that female triplets were not officially reported. Meanwhile we are thrown back for that period on the local and provincial Gazetteers, which in the chapter on untoward or abnormal events sometimes record cases of plural births.

To cite a few instances of this kind in the period of the Manchu dynasty,—the Gazetteer of Ju-chou in Ho-nan (quoted above) enumerates four cases (all males), which occurred in 1770, 1785, 1824, and 1833. In 1797 a triplet birth occurred in Hwa-yang (prefecture of Ch'eng-tu, Se-ch'wan); the case was reported to the throne, and by imperial favor, a picul of rice was granted to the father, Yang Kwo-yü (*Hwa yang hien chi*, Ch. 43, p. 3). The Gazetteer of Mong-chou (prefecture of Hwai-k'ing, Ho-nan) cites only two cases for the years 1682 and 1736. Most Gazetteers which I have looked up are disappointing: thus the Gazetteer of Shen-si Province (*Shen-si t'ung chi*) contains only two cases of triplets, recorded for the years 1470 and 1729.

In the Gazetteer of the Prefecture of Sung-kiang, three cases of triplets are recorded between 1367 and 1640 (according to D. J. Macgowan, *Cosmical Phenomena Observed in the Neighborhood of Shanghai*, *Journal China Branch R. As. Soc.*, II, 1860, p. 74).

The data of the Chinese certainly are defective, and cannot entirely satisfy the anthropologist. We miss, for instance, data concerning the ages of mother and father and order of birth in triplet deliveries (*rang chronologique de l'accouchement* of the French statisticians). Above all, we should desire information as to the vitality and fecundity of the offspring. What the Chinese may boast of, however, is the fact that they possess lists of plural births for periods of the past when nothing of the kind was ever attempted in any country of Europe. In the vital statistics of France, plural births have been recorded only from 1858; and in no country of Europe did they receive any attention before the nineteenth century (in Berlin from 1825).

The sum of 277 triplet births for the Sung and 324 for the time from the T'ang to the Ming inclusive may seem a high figure to the uninitiated; in fact, however, it is strikingly low. During the four years 1907–1910 there was in France a total of 327 triplet births; 91, 93, 68, 75 in the respective years, making a mean average of 81.75 per year (*Statistique général de la France, Statistique du mouvement de la population*, Paris, 1912, p. 56). There were, accordingly, more triplet births in France during those four years than in China in the

course of many centuries. Or, to cite another example, in the period 1835-47, there were in Bavaria 1,050 triplet, 56,062 twin, and 3,413,763 normal births. The frequency of triplets varies in different years and in different countries. In 1855, triplets were produced in Scotland by 11 mothers out of 92,300 births; that is, one in 8,391. Triplet births in Scotland from 1855 to 1901, a period of 47 years, numbered 644, and averaged 116 per million confinements (C. J. Lewis and J. N. Lewis, *Natality and Fecundity*, p.62). I do not go any further into the question of the frequency of triplets in Europe and the proportion of triplets to twin and normal births, as the Chinese data are not comparable, and as figures of total births are lacking for the Sung period. Judging from our experience, it must be stated, however, that the Chinese data can hardly be complete; but there is no way of correcting or adjusting the figures, which we are simply compelled to take for what they are worth. The reader should not forget that the material furnished by the Chinese Annals is not intended as statistics, but merely as a record of extraordinary events in human life. In order to give a certain perspective to the number of multiple births, some data concerning the population may follow here. According to the calculations of E. Biot ("Mémoire sur la population de la Chine," *Journal asiatique*, 1836, p. 461), the population of China under the Sung totaled 43,388,380 in the year 1021, and rose to 100,095,250 in 1102; again in 1223, it amounted to only 63,354,005 (in consequence of the loss of northern China to the Kin). These figures, in all probability, are too high; for they are estimated on the number of families given in the Chinese records, the assumption being made that the mean average of the number of individuals in a family is 5, which, in my opinion, is too high a figure.

The total number of triplets recorded for the T'ang and Sung periods is 279. The distribution of sex in this number is as follows: 273 all males, that is, 97.8 per cent; 4 consisting of 2 males and 1 female, that is 1.4 per cent; 1 consisting of 1 male and 2 females, that is, 0.04 per cent; and only one consisting of 3 females (0.04 per cent). Again, the 15 triplet births of the Yüan dynasty and the 30 of the Ming are all males exclusively. The above percentages perhaps give an approximate clew to the actual frequency of sex in triplet births, as far as China is concerned.

C. J. Lewis and J. Norman Lewis (*Natality and Fecundity*, p. 61, London, 1906), who base their remarkable study on the birth registers of Scotland for the year 1855, during which year there were 11 triplet

births in that country (3 males, 5; 3 females, 3; 2 males and 1 female, 3), offer the following conclusion in regard to the distribution of the sexes: "There is a strong probability that in any given occurrence of triplets the children will all be of the same sex, either all males or all females. If the same ratio held in other nations and in other years, it would amount to a law of triplet production that in over 70 per cent of cases the newly-born children are all of the same sex."

In the period from 1858 to 1865, there were in France 1,005 triplet and 4 quadruplet births; among the former, there were 280 entirely males, 218 entirely females, 256 consisting of 1 male and 2 females, and 251 consisting of 2 males and 1 female. The number of twin births during the same period amounted to 83,279; of these 28,056 were two males, 26,310 two females, and 29,363 consisting of one male and one female (A. Puech, *Annales d'hygiène publique*, XLI, 1874).

Of the 277 triplets recorded for the Sung period, the social standing of the fathers is given in only 110 cases, while the remaining 167 cases are merely recorded as chronological-statistical events. Among the 110 cases, the social status of the fathers is distributed as follows:

		Percentage
Rural population.....	85	76.7
Field-laborers.....	1	1.1
Workmen.....	1	1.1
Soldiers.....	22	20.0
Petty officials.....	1	1.1
Total.....	110	100.0

In the Yüan period, 14 common people and 1 soldier share in the 15 cases of triplets placed on record. In the Ming period, 28 common people and 2 soldiers assume responsibility for 30 cases of triplets recorded. It will thus be seen that the bourgeoisie, inclusive of officials, gentry, and merchants, has no share in these records. Peasants and laborers, of course, formed the majority of the populace; but there is no reason why triplet births, if they had occurred in the upper classes, should not have been reported or recorded.

In arranging our data according to families, we arrive at the result that the members of the families Li, Wang, Chang, and Liu, take the uppermost rank. The male Li reach the score with $16^3 + 1^4$, while two female Li figure with 2^4 ; in the years 986 and 996 respectively we have two male Li participating in triplets. The record of the Wang is $13^3 + 2^4$ (plus one female Wang 1^3); the Chang follow with $9^3 + 2^4$, plus two female Chang (2^3), and the Liu with $9^3 + 1^4$, two

members of this family being conspicuous in the same year (1016). This does not mean, of course, that these four families are more prolific than others, but is merely the index of the fact that they are the most numerous and the most widely spread. The share of the members of the Yang family is expressed by the figure 6^3 , that of the Chao by 5^3 (plus one female Chao 1^3), that of the Cheng by 4^3 (plus one female Cheng 1^4). The Fung, Sie, and Sü have a 3^3 to their credit; the Wei reach the mark $2^3 + 1^4$, the Kwo $1^3 + 1^4$, while the Chu, Hou, Kao, Mong, and Tung, can only boast of 2^3 each. All other families are represented but once. These figures certainly have a mere relative value, and do not allow of any far-reaching inferences. It is assumed by anthropologists that the tendency to multiple births is frequently hereditary, both in the male and female line, more frequently in the former than in the latter; and there is no doubt that heredity is a potent cause in the perpetuation of plural births. In the case of triplets and to a still higher degree of quadruplets the hereditary tendency is particularly striking. Quadruplets often issue from parents who were multiples themselves. Female twins often give birth to twins.

During the 61 years covering our records 1-109 (= 109^3), the high-water mark is reached in the year 991 with 9^3 , and there is only this one year that offers such a record. There are two years (998 and 1015) with 7^3 , two years (995 and 996) with 5^3 , 4 years (982, 983, 1014, and 1016) with 4^3 , 8 years with 3^3 , and 11 years with 2^3 . In the remaining years there is but 1^3 or 0^3 . In the Yüan period we have four years with 2^3 .

QUADRUPLETS

There is a total of 30 on record, the first in A.D. 473, the last in A.D. 1608, a span of 1,136 years.

In this total of 30, 4 quadruplets fall to the lot of a single woman. Twenty-five out of the number of 30, that is $5/6$ or 83.33 per cent, consist of males exclusively. The remaining 5 are distributed as follows: 3 cases consisting of 3 males and 1 female (10 per cent), 1 case being 2 males and 2 females (3.33 per cent) and 1 case being 4 females (3.33 per cent).

In 1907 two quadruplet births in France produced 5 males and 3 females; in 1908 there was one quadruplet birth of 4 boys; in 1909 three quadruplet births produced 10 boys and 2 girls; and in 1910, there was one quadruplet birth of 2 males and 2 females (*Statistique du mouvement de la population*, p. 56).

For 7 cases no personal data are on record; in a single case of the Ming period the father's social status is not indicated. In the remaining 22 cases we find 2 soldiers, 1 falconer, and 19 common people, in all probability, farmers. Again, we accordingly meet here with the same social status of the parents as in the case of triplets.

As to the relative proportion of quadruplet to triplet births, see above, p. 50.

Pliny (VII, 3, § 33) records the example of a quadruplet birth of two males and two females toward the end of the reign of Augustus and ascribed to Fausta, a Plebeian woman of Ostia (Fausta quaedam e plebe Ostiae).

QUINTUPLETS

It is striking and worthy of especial mention that the Chinese Annals do not record a single example of a quintuplet birth; at least I have failed in tracing any. Both Aristotle and Pliny were convinced of such an occurrence. Aristotle (*Historia animalium*, transl. of D'Arcy W. Thompson, p. 584b) states: "Some animals produce one and some produce many at a birth, but the human species does sometimes the one and sometimes the other. As a general rule and among most nations the women bear one child at a birth; but frequently and in many lands they bear twins, as for instance in Egypt especially. Sometimes women bring forth three and even four children, and especially in certain parts of the world. The largest number ever brought forth is five, and such an occurrence has been witnessed on several occasions. There was once upon a time a certain woman who had twenty children at four births; each time she had five, and most of them grew up." Pliny (VII, 3, § 33) has it that in the Peloponnesus a woman was delivered of five children at a birth four successive times, and that the greater part of these survived (*Reperitur et in Peloponneso quinos quater enixa, maioremque partem ex omni eius vixisse partu*),—perhaps the same event alluded to by Aristotle. Nijhoff, in his interesting study "*Vijflinggeboorten*" (Groningen, 1904, 4°) has fully described and figured a case which came under his notice. He further reviews from literary records 29 more cases of quintuplet births, one of which only seems to be of doubtful authenticity. Cf. also S. Shishido, *The Birth of Five Infants at One Parturition* (*Iji Shinbun*, Tokyo, 1901, pp. 433-438).

SEXTUPLETS

In regard to sextuplet birth, I have found only two cases on record. According to the *Gazetteer of Chi-li Province* (*Ki fu t'ung chi*), it was

in 1574 that a woman of the people of Fei-hiang (in Kwang-p'ing fu, Chi-li) brought forth six children at one birth. The name of the woman and the husband is not given. The other case is reported in the *Sū K'ien shu* (Ch. 5, p. 8), a record of Kwei-chou Province, written by Chang Chu in 1805. In a certain village of western Kwei-chou a woman, *née* Wang, gave birth to six sons at one time, both children and mother being well. The author, however, had this merely from hearsay.

Nijhoff (p. 66) reports the case of a sextuplet birth in a peasant family at Castagnola near Lugano (Italy) in 1888 (4 males, 2 females, who were alive at the time of birth, but died in a few seconds) and another from Alburi on the Gold Coast in Africa after Dr. H. Vortisch of the Basle Mission. In the latter case a Negro woman is said to have been delivered of 5 boys and 1 girl, who for lack of care died shortly; the woman stated that it was her fifth deliverance, at the second she had twins, at the third quadruplets, and at the fourth triplets. An Italian woman, who in the fifth month of pregnancy miscarried, expelled six foetuses; the truthfulness of this report is generally conceded (J. Parvin, *Science and Art of Obstetrics*, 3d ed., p. 161). Other cases of sextuplet delivery are described in the *Boston Medical and Surgical Journal*, XXXV, 2, 1847, and by J. W. Kerr and H. Cookman (*Med. Pres. and Circ.*, LXXV, p. 537, London, 1903: five boys and one girl). Cf. also Shishido, *Examination of the Records of More than Five Infants at a Birth* (*Iji Shinbun*, Tokyo, 1901, pp. 1897-1901).

SEPTUPLETS

The Gazetteer of Chi-li Province (*Ki fu t'ung chi*) has it on record that in 1527 a woman, *née* Ch'en, of Ho-kien (Chi-li), was delivered of seven girls at one birth, but that none of them survived. According to Trogus, there was a case of seven children at one birth in Egypt (Et in Aegypto septenos uno utero simul gigni auctor est Trogus, Pliny, VII, 3, § 33). Cases of septuplet birth are mentioned by Roy (Couches avec 7 foetus, in *Revue médicale française et étrangère*, Paris, 1877, I, p. 225); cf. also R. C., *Multiple Pregnancy with a Vengeance* (*Med. Rec.*, LXIII, p. 267, New York, 1903).

It is reported in verse on a tombstone of Hameln that on January 9, 1600, two boys and five girls were born to Thiele Roemer and Anna Breyers. The tombstone is adorned with a sculptured scene which shows six babes in swaddling-clothes on a pillow, while the lucky (?) father holds the seventh on his arm toward the Savior. Nijhoff

(p. 71-72), who has reproduced the tombstone, holds that the question is here of a veritable fact, as at that time no mockery was made of religious subjects. I am far from sharing this opinion. It is well known that the Germans have displayed a great deal of fun and humor on their epitaphs, collections of which have been made. The tombstone itself does not suffice to bear out the historicity of the case. It would be necessary to trace it in the parish-register, death-lists, or any other documents in the archives of the town of Hameln; but this evidence, as far as I know, has not yet come forward.

A case of eight children at a birth, as far as I know, is nowhere on record, but the following curious passage occurs in the book "*Cosmographie de Levant*" (p. 114, Lyon, 1554) by F. André Thevet d'Angoulesme: "Non seulement ce païs abonde en fruits, et herbes: mais aussi en fleurs odoriferentes, Les femmes y sont tant fecondes, qu'elles engendrent communement trois, et quatre, et bien souvent huit enfans: et encores qu'ils naissent au huitième mois, ils vivent: ce qu'aucuns attribuent à la bonté du Nil: Outreplus elles surengendroient, (comme Pline raconte d'une femme d'Alexandrie) ce qui n'est pas tant signe de merveille, que argument de fecondité." Thevet is doubtless influenced by the passage of Pliny, and is somewhat inclined toward exaggerations. I doubt very much that a case of octoplets has ever come under his actual experience: his statement is generalized, but no reference is made to a specific case.

The preceding article discloses the fact that a department of vital statistics, either in connection with the Government or as a private enterprise, is urgently required for China. The motive which principally guided me in writing this notice was to demonstrate by a concrete example the necessity of founding such an institution. It goes without saying that a statistical research into the population of China would mean a considerable advance of our knowledge, from which the economists and sociologists all the world over might learn and benefit, and that the Chinese would yield the most fruitful material for all problems of heredity and eugenics. It is particularly genealogical research that could be carried on in China with most promising results. Another problem which is much on my heart is that of longevity and the average duration of a generation among the Chinese and Japanese; and if nothing interferes, I hope to make a small contribution to this question in the near future.

RACE SUICIDE IN THE UNITED STATES

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The question of the relative rates of increase of the population of old native stock and of that of immigrant stocks is one which has attracted the attention of anthropologists and students of our population movements for half a century or more. Studies of population movements in New England made more than fifty years ago showed that the birth rate among the people of native stock had been falling steadily since 1800, and that the Irish immigrants and their descendants were rapidly supplanting the old native stock. More recent data show that the same process is still going on, only now it is the French Canadians, the Italians, the Slavs and the Jews that are supplanting both the old native stock and the earlier immigrants of Nordic stock from the British Isles, the Scandinavian countries and Germany.

Before we can proceed to a discussion of the questions involved in this process of substitution, we must examine the facts of population increase in various parts of the United States, in order to ascertain how far it is true that the old native American stock and the earlier immigrants are rapidly dying out and being supplanted by newer immigrants.

EVIDENCES OF RACE SUICIDE

The *Registration Report* of Maine for 1910 showed that the three counties in that state having the highest percentages of native stock had the lowest birth rates and also that the death rate exceeded the birth rate, while in the state as a whole the birth rate exceeded the death rate by 4.55 persons per 1,000. The Registration Reports also show that for some years past the number of marriages among the foreign born in Maine has been about 29 per cent of all marriages, while the children born to foreign born parents constitute about 40 per cent of all children born. A comparison of Auburn, a city of about 16,000 inhabitants of predominantly native stock, with Lewiston, a city of about 27,500, having a large French Canadian element, shows that in 1915 the former had a birth rate of 17.4 and the latter

a rate of 27.3. The death rate is somewhat higher in Lewiston than in Auburn, but when allowance is made for this fact the former has a rate of natural increase more than twice as large as the latter—10.5 and 4.6 respectively.

In a study made several years ago, Kuczynski¹ found that the marriage rate was much higher among the foreign born in Massachusetts than among the native born, and also that the birth rate of the former was much higher than that of the latter. According to his calculations the birth rate was 63 per 1,000 native-born "female adults," and 124 per 1000 foreign-born "female adults," during the fifteen-year period 1883-1897. He also pointed out that according to the state census of 1885, 20.18 per cent of the native-born married women had no children, while only 13.27 per cent of the foreign-born married women were childless. This same census showed, too, that the average number of children born to a native married woman was 2.69, while the average number born to a foreign married woman was 4.53.

Numerous other studies confirm the general belief that in the north-eastern states the native population is being supplanted by the foreign-born population and their descendants. Hoffman² says: "Engleman, as the result of his analysis of New England genealogies, shows that while in 1800 the average number of children was 6.1, it had decreased to 4.6 by 1830, to 3.3 by 1860, 2.5 by 1872, and for the upper classes of Boston to 1.8 by 1900." In a footnote on page 678 of this same article Mr. Hoffman states that an original investigation into the facts of American ancestry from published genealogies shows that the average number of children per family in the period 1700-1750 was about seven; 1800-1850 about five; 1850-1900 less than three. To confirm the conclusions justified by the facts found in genealogies he also gives data from the Rhode Island State Census of 1905 showing: (1) That only 71.6 per cent of the native women 15-45 years of age were married, while 82.5 per cent of the foreign women in the same group were married; (2) that the average number of children born to a native white woman was 2.06, while to a foreign white woman it was 3.35 (twenty years earlier the figures were 3.49 and 5.38 respectively); (3) that the proportion of native married women with one child was 23.4 per cent, while that of foreign married women was 16.4 per cent; (4) that only 19.8 per cent of the native married women had more than three children, while 38.7 per cent of the foreign married women

¹ Kuczynski (R. R.).—*Quart. J. Econom.*, 1901, XVI, 1-36, 141-186.

² Hoffman (Frederick L.).—*Decline in the Birth Rate. N. Am. Rev.*, 1909, CLXXXIX, 675-687.

belonged to this class; and (5) that at the age of 25, 39.0 per cent and at the age of 30, 29.1 per cent of the native married women were childless, while for foreign married women at the same ages the percentages were 25.6 and 15.9 respectively.

A study made by the registrar of vital statistics for Michigan¹ on the "fecundity of marriage by nativity" in that state, shows that for the twenty-year period ending with 1894 the number of children born per marriage where the mother was native was 3.2, and that where the mother was foreign both it was 5.6. The Registrar concludes that Michigan is rapidly following Massachusetts and other eastern states in its population movement and that within a short time its native population will be submerged by immigrants and their descendants. He quotes the following from the State Census as being in entire agreement with the conclusions he would draw from his own study of birth rates among the native-born and foreign-born classes:

"Of the 53,228 children tabulated, the parents and grandparents of 10,880 were all native, and the parents and grandparents of 20,080 were all foreign-born. The former number is 1.20 per cent of the native inhabitants with native parents, and the latter is 3.72 per cent of the foreign-born with foreign-born parents. The latter number is 1.85 times the former."

A recent investigation of the size of the families of the graduates of eight eastern women's colleges and one co-educational institution,² shows that the average number of children born to those who have children is 2.1. This figure is somewhat too low because it includes many of the graduates of recent years who have been married but a short time and who, therefore, are not through child-bearing. The average number of children born to graduates in classes prior to 1880 who have married and have had children is 2.9; to those in classes between 1880 and 1890, 2.8 children; and to those in classes between 1890 and 1900, 2.6 children. Inasmuch as it is not safe to assume that the graduates between 1890 and 1900 who were married and had had children were through child-bearing in 1915, when the investigation was made, we shall probably not make a very grave error if we assume that their final average will be approximately the same as that of the graduates between 1880 and 1890—viz., 2.8.

This same investigation shows that of the graduates prior to 1880 only 80.7 per cent of those married had had children; of those in

¹ *Twenty-eighth Registration Report*, Michigan, 1894.

² Van Kleeck (Mary),—*J. Ass. Colleg. Alum.*, May, 1918.

classes between 1880 and 1890 only 77.7 per cent; and of those in classes between 1890 and 1900 only 78.3 per cent. Thus we see that the graduates of these colleges who marry and raise families have scarcely enough children to replace themselves and their husbands in the next generation, to say nothing of the 20-22 per cent who marry and have no children and the 40-50 per cent who do not marry. If we take for granted that there is a bachelor for every unmarried woman among college graduates the situation might be expressed as follows: Out of each 1,000 men and women belonging to this class 400 do not marry, of the 600 married couples 120 are childless, leaving 480 who have children with a total of 1,344 children born to them, of whom approximately 1,150 live to reach the average age of college graduates. A few of these will die before they reach the customary age of marriage. It is, therefore, a conservative estimate to say of this class as a whole, that deaths are to births as 2000 : 1100, or 20 : 11.¹ It is very clear that this class is not sustaining itself and that the conclusions arrived at by the studies cited above certainly hold true for this particular group of the native population.

An investigation made by the Immigration Commission several years ago still further confirms the general belief that the native population is being rapidly supplanted by the immigrant stocks. In this investigation it was found that in Rhode Island the average number of children born to native white women of native parentage, married ten to nineteen years, was 2.5, while the average number born to white women of foreign parentage, married ten to nineteen years, was 4.5; for Cleveland the figures were 2.4 and 4.3; for Minneapolis 2.4 and 3.8; for certain rural counties in Ohio 3.4 and 4.5; and for certain rural counties in Minnesota 3.4 and 5.2, respectively.

After one has examined a number of studies such as those referred to above, he is likely to feel that it is only a matter of a few decades (with immigrants coming as rapidly as they were before the war) until the older stocks, Celtic, Teutonic and Scandinavian as well as Anglo-Saxon, will be supplanted by the newer Latin, Slavic and Hebrew stocks.

The evidence submitted is seemingly overwhelming. It will be noticed, however, that most of the data upon which these studies are based have been gathered from the northeastern states—largely

¹ The death rate used in the above calculation is the extremely low one found by this study to exist in this class—viz., that only 13.0 per cent of the children of graduates prior to 1880 had died by 1915.

from New England. The question naturally arises, therefore, whether the population movements of this section of the country are typical of those taking place elsewhere. It seems to the writer that the probabilities are against this being the case. The social and industrial conditions in the northeast are so entirely different from those in most other sections that it would be strange if the population movements there were the same in nature and extent as they are in other parts of the nation. The northeast is a relatively densely settled area in which manufacturing and commerce are the predominant interests, while agriculture is the predominant interest in most of the other states. Again, the population of the northeast is much more heterogeneous than that of most other sections. Not only did the northeast retain its due share of immigrants before 1890 but it has retained most of those who have come in since that time, for the newer stocks which occasion so much concern to most writers on race suicide are to be found mostly in the northeast and a few large cities along the Great Lakes.

Since this is the case it becomes necessary, in order to study population movements, to classify our population not only on the basis of state of residence but also on the basis of type of work done. For this purpose I have adopted the Census classification of urban and rural. I believe that if we can measure the relative rates of increase in these groups as well as in the different states we can arrive at a more accurate notion of population movements in our country.

If we had good statistics of births and deaths for all states and their minor civil divisions, we could tell what the natural increase is in cities, counties and even townships, as well as in the state as a whole. By using the data of the Federal Census in connection with data from the vital statistics of the states, we could compare the rate of growth in political units having populations chiefly composed of different stocks. Unfortunately only a few states have comprehensive birth statistics and these must be used with many reservations. For one thing, there is good reason to believe that the data for the rural districts are more defective than those for the cities, so that a comparison between the rates of growth in these two classes on the basis of published vital statistics is fraught with danger. In addition to this difficulty all places having less than 10,000 people are classed as rural in the federal reports on births, while only those having less than 2,500 are so classed in the decennial census. Furthermore, the birth rates and death rates for intercensal years are based on estimates of popula-

tion and are liable to a considerable error with regard to any particular city, county or state. Lastly, the age and sex distribution in different areas are so unlike that crude birth rates and death rates tell us but very little regarding the fecundity of women in these different areas.

In view of these facts the writer has prepared some tables from data given in the Federal Census of 1910 which he believes will show the most significant population movements in the United States better than such birth statistics as we now have.

The general method used in the preparation of these tables—that of showing the proportion of children at certain ages to women of child-bearing age—is one which Professor Wilcox has made familiar to all those interested in our population problems. It is not claimed that these tables show us the exact rates of increase in the urban and rural populations of the different states, but merely that they will enable us to determine with fair accuracy what groups are contributing most children to the next generation. This is all we need to do in a discussion of race suicide in the United States. For the phrase race suicide has never been used by those conversant with population facts to refer to a low rate of natural increase, but rather to the fact that the children contributed by one nation or class to the next generation were relatively fewer than those contributed by another nation or class. The natural consequence of such a situation is that the nation or class with a low child-contributing rate is supplanted sooner or later by a nation or class with a higher child-contributing rate. In the United States the serious question is, whether the people from northern and western Europe—British, Scandinavian and Teutonic—are being supplanted by those from southern and eastern Europe—Mediterranean, Slavic, and Hebrew—and not whether the natural increase of the nation as a whole is sufficiently high. There seems to be little doubt that the rate of natural increase for the nation as a whole (*i.e.*, annual excess of births over deaths per 1,000 of the population) is as high as that of most civilized countries.

TABLE I—SHOWING THE PROPORTION OF CHILDREN TO WOMEN IN THE UNITED STATES, THE GEOGRAPHIC DIVISIONS AND THE STATES: ALSO THE PROPORTION OF WOMEN AND OF THE NATIVE BORN OF NATIVE PARENTS IN THE TOTAL POPULATION OF THESE DIFFERENT AREAS

Geographic Area	No. Children Under 5 Yrs. per 1,000 Women 15-44 Yrs.	No. Children 5-9 Yrs. per 1,000 Women 15-44 Yrs.	Percent of Total Population Comprised by Women 15-44 Yrs.	Percent of Total Population Native Born of Native Parents
UNITED STATES: WHITES				
Urban.....	382	341	25.4	41.9
Rural.....	603	555	21.2	64.1
NEW ENGLAND STATES:				
Urban.....	384	345	25.7	33.9
Rural.....	458	437	20.4	69.8
MAINE:				
Urban.....	388	359	24.3	55.1
Rural.....	493	458	20.2	78.9
NEW HAMPSHIRE:				
Urban.....	385	353	24.7	41.0
Rural.....	428	409	20.3	71.5
VERMONT:				
Urban.....	392	370	24.1	54.3
Rural.....	489	472	20.0	73.6
MASSACHUSETTS:				
Urban.....	376	336	26.2	30.8
Rural.....	412	399	21.3	58.6
RHODE ISLAND:				
Urban.....	390	349	25.7	28.2
Rural.....	428	396	21.0	66.2
CONNECTICUT:				
Urban.....	405	363	25.2	33.1
Rural.....	450	441	20.3	56.4
MIDDLE ATLANTIC STATES:				
Urban.....	402	351	26.2	34.4
Rural.....	518	477	21.2	67.0
NEW YORK:				
Urban.....	379	332	26.9	27.2
Rural.....	420	407	21.2	66.1
NEW JERSEY:				
Urban.....	420	374	25.8	33.6
Rural.....	440	382	22.4	58.7
PENNSYLVANIA:				
Urban.....	433	373	25.4	45.8
Rural.....	599	534	20.9	69.2
EAST NORTH CENTRAL STATES:				
Urban.....	382	340	25.9	41.7
Rural.....	523	506	21.3	66.5
OHIO:				
Urban.....	370	324	26.1	51.0
Rural.....	500	478	21.4	79.6
INDIANA:				
Urban.....	361	335	25.7	67.8
Rural.....	503	493	21.7	87.0
MICHIGAN:				
Urban.....	395	347	25.6	35.5
Rural.....	535	513	20.7	50.8

TABLE I—(Continued)

Geographic Area	No. Children Under 5 Yrs. per 1,000 Women 15-44 Yrs.	No. Children 5-9 Yrs. per 1,000 Women 15-44 Yrs.	Percent of Total Population Comprised by Women 15-44 Yrs.	Percent of Total Population Native Born of Native Parents
ILLINOIS:				
Urban.....	388	342	26.1	32.3
Rural.....	529	507	21.8	68.4
WISCONSIN:				
Urban.....	398	369	25.4	28.5
Rural.....	562	557	20.8	35.9
WEST NORTH CENTRAL STATES:				
Urban.....	344	317	26.4	51.2
Rural.....	582	548	21.3	58.5
MINNESOTA:				
Urban.....	353	319	26.1	29.2
Rural.....	598	602	20.3	26.7
IOWA:				
Urban.....	335	325	25.9	58.2
Rural.....	526	508	21.8	58.8
MISSOURI:				
Urban.....	328	303	27.2	55.0
Rural.....	583	549	21.6	85.5
NORTH DAKOTA:				
Urban.....	384	325	26.9	37.7
Rural.....	716	607	20.6	27.0
SOUTH DAKOTA:				
Urban.....	355	326	25.9	51.5
Rural.....	618	563	21.2	40.6
NEBRASKA:				
Urban.....	361	321	26.3	51.8
Rural.....	581	534	21.7	54.6
KANSAS:				
Urban.....	367	339	25.7	70.3
Rural.....	567	525	21.5	71.8
SOUTH ATLANTIC STATES:				
Urban.....	393	354	26.4	54.2
Rural.....	678	604	21.5	62.2
DELAWARE:				
Urban.....	401	344	25.1	52.9
Rural.....	447	455	21.8	72.7
MARYLAND:				
Urban.....	366	348	26.4	50.7
Rural.....	516	505	22.2	67.9
DISTRICT OF COLUMBIA:				
White.....	299	279	27.4	50.4
VIRGINIA:				
Urban.....	390	353	26.5	59.4
Rural.....	646	599	21.6	65.7
WEST VIRGINIA:				
Urban.....	410	359	26.3	74.8
Rural.....	703	615	21.0	87.8
NORTH CAROLINA:				
Urban.....	465	395	26.3	61.2
Rural.....	716	620	21.4	68.4

TABLE I—(Continued)

Geographic Area	No. Children Under 5 Yrs. per 1,000 Women 15-44 Yrs.	No. Children 5-9 Yrs. per 1,000 Women 15-44 Yrs.	Percent of Total Population Comprised by Women 15-44 Yrs.	Percent of Total Population Native Born of Native Parents
SOUTH CAROLINA:				
Urban.....	441	379	26.2	49.6
Rural.....	702	603	21.9	42.7
GEORGIA:				
Urban.....	418	372	26.6	52.4
Rural.....	727	639	21.4	53.5
FLORIDA:				
Urban.....	437	387	25.7	37.1
Rural.....	683	607	21.1	54.8
EAST SOUTH CENTRAL STATES:				
Urban.....	378	349	26.7	54.4
Rural.....	696	619	21.6	67.2
KENTUCKY:				
Urban.....	340	325	27.0	58.2
Rural.....	669	609	21.6	88.8
TENNESSEE:				
Urban.....	366	335	27.2	57.2
Rural.....	671	599	21.9	80.4
ALABAMA:				
Urban.....	453	398	26.0	49.8
Rural.....	752	651	21.3	56.2
MISSISSIPPI:				
Urban.....	427	390	26.1	46.7
Rural.....	727	641	21.5	41.5
WEST SOUTH CENTRAL STATES:				
Urban.....	405	384	26.0	58.4
Rural.....	729	658	21.2	67.7
ARKANSAS:				
Urban.....	396	371	26.5	61.0
Rural.....	754	653	21.2	69.5
LOUISIANA:				
Urban.....	391	385	26.2	43.8
Rural.....	765	699	21.0	48.2
OKLAHOMA:				
Urban.....	421	379	25.5	76.0
Rural.....	735	658	21.0	79.8
TEXAS:				
Urban.....	405	388	26.1	59.5
Rural.....	708	651	21.3	69.1
MOUNTAIN STATES:				
Urban.....	382	350	25.5	51.9
Rural.....	641	564	19.9	57.8
MONTANA:				
Urban.....	378	340	24.7	40.3
Rural.....	570	505	18.7	44.7
IDAHO:				
Urban.....	375	347	24.4	62.7
Rural.....	674	598	19.9	62.5
WYOMING:				
Urban.....	396	348	22.6	51.7
Rural.....	629	528	18.2	56.8

TABLE I—(Continued)

Geographic Area	No. Children Under 5 Yrs. per 1,000 Women 15-44 Yrs.	No. Children 5-9 Yrs. per 1,000 Women 15-44 Yrs.	Percent of Total Population Comprised by Women 15-44 Yrs.	Percent of Total Population Native Born of Native Parents
COLORADO:				
Urban.....	321	307	26.9	56.9
Rural.....	593	525	20.6	62.1
NEW MEXICO:				
Urban.....	425	409	26.2	74.0
Rural.....	679	609	20.8	78.8
ARIZONA:				
Urban.....	439	385	24.5	42.1
Rural.....	634	545	19.4	39.6
UTAH:				
Urban.....	515	445	24.3	42.5
Rural.....	792	693	19.9	48.9
NEVADA:				
Urban.....	290	279	25.6	49.8
Rural.....	425	366	18.6	41.8
PACIFIC STATES:				
Urban.....	301	271	25.7	46.9
Rural.....	509	480	19.9	54.8
WASHINGTON:				
Urban.....	335	303	24.6	48.7
Rural.....	566	529	19.6	54.2
OREGON:				
Urban.....	288	263	25.5	55.4
Rural.....	524	507	20.0	67.5
CALIFORNIA:				
Urban.....	290	261	26.2	44.4
Rural.....	469	439	20.0	50.0

THE PROPORTION OF CHILDREN IN THE RURAL AND URBAN POPULATION

The above data throw considerable light on the child-producing rates of women in the rural and urban populations of the United States and its constituent parts.

In the United States as a whole the white women¹ of child-bearing ages in the rural districts had 221 more children under five years of age to each 1,000 than the women of the urban districts—i.e., each 1,000 rural women 15-44 years of age had about 58 per cent more children under 5 living at the time of the census than the women in the urban districts. The actual numbers of women and children in these two classes are well worth giving. There were 10,382,634 women in this age group in the urban districts having 3,966,957 children under 5, while there were only 8,877,985 women in the same age group in the rural districts but they had 5,355,957 children under 5. Although there were only 85.5 per cent as many women in the

¹ The discussion will refer only to the white population unless negroes should be specifically mentioned. Table I gives data for white population only.

rural districts as in the urban yet they had 35 per cent more children. If the women in the urban districts had had as many living children under 5, per 1,000, as the women in the rural districts they would have had a total of about 6,261,000 instead of only 3,966,957.

Not only in the United States, as a whole, was the proportion of children to women larger in the rural districts than in the urban districts, but this was also true for every state in the Union. In the New England states the difference was not large—a little over 19 per cent—and in Massachusetts it was only 9.6 per cent. In some states, however, the difference was over 80 per cent—86.5 per cent in North Dakota and 83.3 per cent in Tennessee.

THE URBAN POPULATION

In the urban population the proportion of children is generally between 300 and 400 to 1,000 women of between 15 and 44 years. In a few states of the northeast, in most of the southern states and in a few of the mountain states it exceeds 400. In only one state—Utah—does it exceed 500, while in two states only—California and Oregon—and the District of Columbia, is the proportion of children less than 300. In spite of several exceptions, I believe one is justified in making the following general statement regarding the proportion of children in the urban population of the different states:

Those states in which the white population is mostly of the older stock—the southern states—have the largest proportion of children; those states having a considerable percentage of newer immigrants—in their population—mainly in the northeast—have the second largest proportion of children; next come those states in which older immigrants predominate—*e.g.*, Wisconsin and Michigan—and lastly those states in which old native stock and the older immigrants seem to be pretty nearly equal in numbers.

In view of these facts there can be no doubt that the newer immigrants who live chiefly in the cities of the northeast and in those of the Great Lakes region are contributing by far the largest increment to our urban population year by year by an excess of births over deaths.

THE RURAL POPULATION

In sharp contrast to the great uniformity in proportion of children to women in the urban population is the wide variation in the proportion of children in the rural population—from 412 in Massachusetts to

792 in Utah. In general, the proportion is smallest in those states of the northeast where agriculture is of least importance and greatest in the south and southwest where agriculture occupies the attention of almost the entire white population. The states in the middle west and west have, as a rule, a larger proportion of children than the states of the northeast but a smaller proportion than those of the south and southwest, and in most of these states the proportion of the population engaged in agriculture is greater than in the states of the northeast but smaller than in the states of the south and southwest.

The full significance of the relatively high proportion of children in the rural population becomes clear when we consider this fact in connection with the data in the fourth column of Table I. In practically every state the rural population contains a much greater proportion of native born of native parents than the urban population. Of the rural white population over three-fourths is native born of native parentage, while only about four-ninths of the urban white population belongs to this class. Furthermore, the one-fourth of the rural population which is of foreign stock is composed chiefly of Teutonic, Scandinavian, Irish and English immigrants and their children, so that the bulk of our rural population is of the same general strain.

In view of the facts adduced above there seems no good reason to fear that race suicide is taking place in the whole of the United States. The older native stock is not yielding its place to the newer immigrants except in the cities of the northeast. It is the rural population apparently which is destined to supplant the city population. Although the newer immigrant women who live very largely in the cities have a higher birth rate than the native women with whom they come into competition, yet they do not have as high a birth rate as the rural women. Moreover, they soon succumb to the influences of the city environment so that their birth rate becomes lower. In the investigation of the Immigration Commission in Rhode Island it was found that of white women of foreign parentage under 45 years of age and married 10-19 years, 7.2 per cent of the first generation had no children and 10.5 per cent of the second generation, while in rural Minnesota the percentages were 2.6 and 2.8 respectively. The average number of children born to women of these groups in Rhode Island was 4.7 in the first generation and 3.9 in the second generation, while in rural Minnesota the averages were 5.5 and 4.7 respectively. This same investigation also showed that the percentage of childlessness among

the immigrant women of certain cities, married 10-19 years, was greater than among the native women, married the same length of time, in certain country districts.

TABLE II—SHOWING NUMBER OF CHILDREN UNDER 5 YEARS OF AGE PER 1,000 MARRIED, WIDOWED OR DIVORCED WHITE WOMEN 15-44 YEARS OF AGE; ALSO PERCENTAGE OF THESE WOMEN ARE OF ALL WOMEN OF THESE AGES IN THE URBAN AND RURAL POPULATIONS OF THE UNITED STATES AND ITS GEOGRAPHIC DIVISIONS. CENSUS 1910

Geographic Area	Percentage Married, Widowed or Divorced Women 15-44 are to all Women 15-44		Number of Children Under 5 to 1,000 Married, Widowed or Divorced Women	
	Urban	Rural	Urban	Rural
United States	57.8	64.6	660	933
New England	53.9	63.8	714	718
Middle Atlantic	56.7	62.7	709	827
East North Central	59.2	63.2	645	828
West North Central	57.4	62.0	599	937
South Atlantic	58.4	63.7	672	1066
East South Central	59.8	66.5	632	1047
West South Central	63.9	69.5	633	1050
Mountain	63.6	70.6	601	907
Pacific	61.6	67.6	489	754

It may be argued against the position taken here that the reason the proportion of children is higher in the country than in the city, is because the percentage of women of child-bearing ages in the total population is much smaller in the rural districts than in the cities (see column 3 of Table I), and also that the percentage of married women is higher in the rural districts than in the cities (columns 1 and 2 of Table II). These facts cannot be disputed but they do not prove that country women do not raise more children than city women. They merely point to two of the reasons why the proportion of children to women is larger in the country than in the city. Table II, columns 3 and 4, shows that when allowance is made for the fact that the percentage of women is smaller in the rural districts than in the cities and also for the fact that more of them marry, the proportion of children to women is still much larger in the rural districts. In the United States as a whole 1,000 married women between 15-44 years, living in the country, have 41.3 per cent more children under 5 than 1,000 city women. In New England alone there is practically no difference in the number of children per 1,000 married women 15-44 in the rural and urban districts. In the Middle Atlantic States the difference is 16.6 per cent, in the East North Central States it is 28.4

per cent, while in all other sections it is over 50 per cent. The married women of the urban districts constituted 51.1 per cent of all married women but they had only 42.5 per cent of the children under 5.

Thus we see that the facts regarding the proportion of children to married women also support the conclusions drawn from Table I. It is the women in the rural districts who are raising the greater part of the children of the next generation, and these women are largely of the same basic stock as that by which the nation was originally constituted.

The facts regarding where the children of the United States are found show beyond question that so far as race suicide is a fact it is confined to certain classes of the urban population, and to the rural population of a few states where urban industrial life is so predominant that its influence is strongly felt even in the rural districts. It is due to the fact most people have only studied the movements of population in a few states where urban industrial life is almost universal that there is such widespread misapprehension of the real situation. I would not be understood to overlook the likelihood that the older stocks in this country may be supplanted by the newer immigrants. But, in my judgment, this will not come about by the immigrant mother raising more children than the mother of older stock (so long as the newer immigrant women live in cities and the women of older stocks live in the country), but rather by there being more women of these newer stocks than of the older stocks—*i.e.*, immigration may be so large as to swamp the older stocks. The influx of people from other countries is, in many respects, a separate problem from that of race suicide and will only be touched upon in this paper where necessary.

DIFFERENCES IN DEATH RATES IN THE URBAN AND RURAL POPULATION

The following table gives in very brief form the best data available regarding the differences in the death rates of the urban and rural population:¹

This table shows that the death rates for both sexes are considerably higher in the city than in the country. There is one exception. Women at the age of 20 have a slightly lower death rate in the city than in the country. Moreover, there is no doubt whatever that these

¹ All places having under 8,000 population in 1900 and under 10,000 population in 1910 are considered rural. As will be pointed out below this method of determining urban and rural tends to exaggerate the death rate in the rural population. These data are compiled from "United States Life Tables" published by the Bureau of Census, 1916.

data understate the difference in death rates because the population of all places having between 2,500 and 10,000 is included with the rural population and in the northeast such places are usually manufacturing towns. In these small manufacturing towns the living conditions are often as bad or even worse than they are in the large cities and so including these towns with the rural districts would undoubtedly raise the death rates of the latter.

NUMBER OF DEATHS PER ANNUM PER 1000 PERSONS LIVING AT DIFFERENT AGES:
ORIGINAL REGISTRATION STATES:¹ 1910 (WHITES ONLY)

	Males		Females	
	Urban	Rural	Urban	Rural
Under 1 year of age.....	133.80	103.26	111.23	84.97
During tenth year.....	2.88	2.17	2.52	1.88
During twentieth year.....	4.49	4.31	3.82	3.97
During thirtieth year.....	6.83	5.33	6.08	5.44
During fortieth year.....	11.61	6.90	8.58	6.53
During fiftieth year.....	18.34	10.24	13.74	9.43
During sixtieth year.....	36.07	21.19	28.65	18.72
During seventieth year.....	69.42	48.79	59.16	45.12

Some studies of infant mortality made by the U. S. Children's Bureau show beyond question that the death rate of infants under 1 year is much smaller in the open country than in cities. In Waterbury, Conn., the infant mortality rate (the number of children dying during the first year of life per 1,000 born alive) was found to be 122.7; in Saginaw, Mich., it was 84.6; in Brockton, Mass., it was 96.7; in Johnstown, Pa., it was 134.0; and in Manchester, N. H., it was 165.0. In a rural district in Montana the infant mortality rate (approximate) was found to be 71; in a rural district in Kansas it was 40; in a low land rural district in North Carolina it was 48.1 for the whites and 64.4 for the negroes.

The North Carolina report says:²

"A comparison of the findings of these rural surveys with the findings of infant mortality studies in cities and towns, tends to confirm the impression that rural conditions are distinctly more favorable than urban conditions to infant life." All of the mortality reports issued by the Census Bureau confirm this view. In Massachusetts

¹ The original registration states are chiefly in the northeast.

² Rural Children in Selected Counties of North Carolina, *Children's Bureau Pub.* No. 33, 1918, 37.

the infant mortality rate for the "Registration Cities" was 102, while in the rural part of the registration area of Massachusetts it was 92.¹ But this is not a fair comparison, because many people who are living under urban conditions are included with the rural population. A fairer comparison will be between the rate of the registration cities and that of the rural area in those states where the rural area includes the largest proportion of population really living in the open country. In the cities of the registration area in 1915 the infant mortality rate for white children was 102, in the rural part of Michigan it was 78, while in the rural parts of Minnesota (the most representative agricultural state in the registration area) it was only 67. Although, as was mentioned above, the incompleteness of the registration of births (the Children's Bureau has found over 10 per cent of the births unregistered in all of the cities where it has made investigations) renders these rates highly inaccurate, yet they are of value for purposes of comparison,² and when considered in conjunction with the other data given above, show beyond doubt that the chances of a baby living through the first year are from 50 per cent to 100 per cent greater in the country than in the city.

The studies of the U. S. Children's Bureau also show that the infant mortality rate of children born to foreign mothers is generally much greater than of those born to native mothers. In Saginaw, Mich., the infant mortality rate of children born to native mothers was 70.5, while of those born to foreign mothers it was 127.6; for Waterbury, Conn., the rates were 97.9 and 134.8 respectively; for Johnstown, Pa., 104.3 and 171.3; for Manchester, N. H., 128.1 and 183.5; and for Brockton, Mass., 101.5 and 92.0. Brockton is the only city in which the infant mortality rate among the children of natives was higher than among the children of foreigners. Of this situation the report on infant mortality in Brockton says: "Few, if any, New England manufacturing cities have shown similar results."³ In the study of the families of the graduates of women's colleges referred to above it was found that the infant mortality rate was only 45.

¹ The rural part of the registration area includes all places of less than 10,000 inhabitants as well as the open country.

² If the situation in Kansas is at all typical of that in other states the comparison between infant mortality rates in the city and country on the basis of registration reports is in favor of the city for it was found that unregistered births were much more common in the country than in towns.

³ Infant Mortality: Results of a Field Study in Brockton, Mass., *Children's Bureau Pub.* No. 37, 1919, 56.

The facts given above justify the conclusion that in the United States, as a whole, the infant mortality rate of children of native mothers is not more than 55 to 65 per cent of that of children of foreign mothers.

REASONS FOR A LARGER PROPORTION OF CHILDREN TO WOMEN IN THE RURAL DISTRICTS THAN IN THE URBAN DISTRICTS

The reasons which explain the fact that there is a larger proportion of children to women in the country than in the city are of two kinds: (1) those which explain the lower death rate in the country, and (2) those which explain the larger average number of children born to country women.

REASONS FOR A LOWER DEATH RATE IN THE COUNTRY

The investigations of the U. S. Children's Bureau enable us to say with considerable certainty why the infant mortality rate is lower in the country than in the city. One of the chief causes of death among infants is found to be gastric and intestinal diseases. These diseases can be avoided to a large extent by proper feeding. The following quotation shows that country babies fare better than city babies in this respect:¹

"If the feeding history of these country babies in Kansas is compared with that of the city babies of native mothers in Johnstown, Pa., and Manchester, N. H.—the first two cities where this study was made by the Children's Bureau—and in Akron, Ohio, the larger of the cities of the Middle West, we find that exclusive breast feeding is much more common through the first nine months in this Kansas county than in any of these (with the exception of the last three months in Akron), and, conversely, that artificial feeding is even more markedly absent. Since breast feeding, especially in the early months, is proved and acknowledged to be an important factor in protecting a baby's chance of life, this fact of the unusual prevalence of breast feeding probably accounts, in part at least, for the low death rate among this group of country babies."

Quotations might be made from other reports to the same effect but there is no need to accumulate evidence on this point.

Another class of important causes of death among infants is diseases of early infancy and malformations which include premature birth, congenital debility, injuries at birth, etc. In Waterbury, 31.6 per cent of all infant deaths were due to conditions existing before the birth of the child or to injury and accident at birth; of those that

¹ Maternity and Infant Care in a Rural County in Kansas. *Children's Bureau Pub. No. 26*, 1917, 42.

died under two weeks, 72.7 per cent dies from these causes. It has been proved conclusively that many deaths from these causes are preventable if the mother has good prenatal care and the services of a skilled obstetrician during confinement; and the investigations of the Children's Bureau show that rural mothers generally have better care than mothers among the poorer classes in our cities.

The social and economic causes which underlie these and other medical causes of infant deaths cannot be discussed here. Suffice it to say that poor housing, low wages, work of the mother outside of the home, ignorance, etc., all contribute to a high infant death rate and that their influence is felt more among the workers of our cities than in the open country.

Out-of-door life of country people is an important cause of their lower death rate. We have no way of measuring the influence of this factor on the health of people; but the results of the physical examinations for the first draft show that those states which are most typically agricultural had a larger percentage of physically qualified men than those states which are most typically industrial and commercial. In Kansas 77.22 per cent of those examined were physically qualified; in Nebraska 79.85 per cent; in South Dakota 85.87 per cent; and in Iowa 77.82 per cent. These are all typically agricultural states in which the city population is relatively small, so that boys from the farms constituted a very large percentage of all those examined. On the other hand, in Massachusetts only 64.52 per cent of those examined were physically qualified; in Connecticut 53.70 per cent; in New York 69.47 per cent; and in Pennsylvania 53.33 per cent. These states are largely urban, most of the people being engaged in manufacturing, commerce and mining. The writer believes that much of this difference is due to the greater healthfulness of the outdoor life of country people. He is well aware that the country home and its surroundings are often subject to criticism from the standpoint of health. In spite of deficiencies, however, he believes that the average country home is a more healthful place to live than the average home of a working class family in the city, and that the better class of country homes are more healthful than the better class of city homes. At its worst the country has no counterpart of tenement life in the big cities and shanty life in mining camps and mill towns; at its best the country has homes superior in healthfulness to the homes of the wealthy. The proof of this latter statement is to be found in the fact that wealthy city people actually spend a great deal of their time away from their city homes out in the country.

Another reason for the lower death rate in the country is the fact that people there are closer to a pure food supply. Country people still prepare for themselves much of what they eat. They kill their own poultry, pork, and veal to a large extent. They can much of the fruit and vegetables they use during the winter besides having an abundance of fresh vegetables during the season. Many kinds of fruits and vegetables can be stored so that they are available, practically fresh, during a large part of the year. It may seem to many that our present system of distribution makes it possible for the city dweller to have just as good a quality of fresh food as the farmer and that, therefore, the difference in kind of food used by these groups is not an important cause of difference in death rates. It is true that it is possible for the city dweller to have just as good a quality of food as the farmer, but as a matter of fact only the well-to-do secure the best quality. Fresh, wholesome food in sufficient amount is beyond the means of the majority of city dwellers. If one doubts this let him read the reports of city health commissioners and of the physicians employed by school boards to make examinations of the children; or, let him spend a few hours in the more densely populated parts of any moderate-sized or large city and watch the poor buying their food.

Another phase of this situation in the city is that those who have the means to secure an abundance of the best food are usually those who lead more or less sedentary lives. These people, as a rule, do not take enough exercise to use up their food and get rid of waste matter. The farmer, on the other hand, may eat very heartily but his active life renders him less likely to suffer from over-eating. The writer has often been impressed with the fact that in the cities one sees large numbers of soft flabby men while in the open country one seldom sees such a man, the farmers being generally lean and hard.

The relative security of the farmer's position is another reason for a lower death rate in the country. He is not harrassed by the uncertainty of his job and income, as a great proportion of the salaried and wage-earning classes in the city. He does not need to fear that some machine will be invented to take his job, nor that he will be turned off in hard times because of lack of work. There is no danger that his industry will move away from him, forcing him to take up some new work or spend all of his savings in moving his family to a new home, nor do strikes and lock-outs affect the farmer in any appreciable degree. Furthermore, the farmer does not have to compete with an ever renewed supply of immigrant laborers having a lower

standard of living. This does not mean that the farmer does not have his "hard luck" just as the city laborer does, but that is not likely to force him into such dire straits as it does the latter. If crops are a failure the whole neighborhood feels it, but no farmer is likely to lose his position as a farmer because of that. He receives a temporary set-back but he is in little danger of being forced to rely on public charity to see him through. As a result of this greater security of life the farmer should be, and it is reasonable to believe is, less subject to worry than the city man, and that worry affects health is unquestionable.

Country people are also less affected by accident and occupational diseases than city people. One proof of this is found in the fact that it is the practise of companies selling insurance to the working classes in cities to charge them a much higher premium than they do farmers and those in other occupations. Of a total of 1,222 *fatal* industrial accidents reported to the Canadian Department of Labor during 1918 only 36 or 2.9 per cent were in agriculture. In 1917 the percentage was 3.2. About two-fifths of the male population in Canada is engaged in agriculture. If further proof is needed that accidents are a cause of higher death rates in the city than in the country it may be found in almost every volume of the Monthly Labor Review. In the metal mines in 1916 there were 3.62 *fatal* accidents per 1,000 of 300-day workers; in 1917, 4.44; while there were 250.64 accidents all told in 1916 per 1,000 of 300-day workers; and 240.97 in 1917. Coal mining is even more deadly (4.25 fatalities per 1,000 of 300-day workers in 1917) while train service, steel work and quarrying take from 2 to 4 per 1,000 of 300-day workers each year.

The fatal accidents in industry, however, do not contribute so largely to the general death rate of city workers as the lesser accidents whose effects are not directly felt. Even with compensation from the employer, the city worker's family is more likely to become destitute when his wages cease than is the farmer's when he suffers injury. The farmer has more resources to fall back upon. His family is still an economic unit, in which each member, from a very early age, can contribute something to the welfare of the whole, while in the city this is not the case. In a pinch, the farmer boy, with the help of his mother and sisters, can keep things going while the father is unable to work. And if the farmer's family is unable to get along without aid the neighbors will usually see them through. Friendly aid of his neighbors has saved many a farmer from the worry of wondering how

he was going to care for his family during the ensuing winter. It is almost impossible for people who are neighbors in the modern industrial community to render one another sufficient aid, as country neighbors do, even if they were disposed to do so.

Still another cause of the lower death rate in the country is what may be called the lower tension of competition in the rural districts. This manifests itself in a variety of ways. Among men engaged in brain work (executives of all kinds and professional men) there is an intense competition for preferment. Most of these men are animated by the desire to "make good." There is, generally, a position just ahead for which they are striving. Usually there are several competitors for each job so that a man must be continually on the alert. There is no place where he can stop and relax, for if he does some one will step ahead of him and get the coveted prize. Besides most men in these groups have a real struggle to make their incomes cover the standard of living which they feel is essential to their success.

Among laboring men there is a somewhat similar process going on. There is the never-ending conflict of the skilled artisan with the machine designed to do his work; there is the constant change in methods and processes to which the man who has become settled in his habits finds it difficult to adjust himself; there is the competition between the skilled and unskilled worker as new machines are invented; there is the competition between native worker and the immigrant with a low standard of living; and, finally, there is the competition between men and women. All this struggle to keep one's place is almost unknown in the country. The farmer may become old-fashioned and work with inferior stock and tools but yet he can hold on and make a fair living. He has little need to fear some younger man or some immigrant can crowd him out if he does not care to go. And yet in many farming communities there is enough competition to keep the farmer truly progressive.

Another way in which the keener competition in the city manifests itself is in the attitude of women towards dress and home equipment. The continuous incitement to dress well and to vie with one's neighbors to which most of the better classes of city women are subject is very largely lacking in the country. In the city the success of the husband and the social position of the family are judged very largely by the outward show its members make. So "good dressing" and the like are indulged in not merely for the satisfaction of personal vanity, but also because they are the assertion of the right to and the means

of attaining a definite social position in the community. It is almost inevitable that this should be so where neighbors and friends only know one another superficially.

The country woman, on the other hand, does not need to assert her claims to a social position for the family by means of dress and other externals. Her neighbors know whether her husband owns his farm and whether he lends or borrows money. She cannot impress her neighbors with outward show. In addition, the security of her position and, in many cases, the substantial prosperity of the family, render her more or less indifferent to the outward show of things.

In view of these differences in living conditions in the country and the city the writer believes that the former is more favorable to health and that it will remain so for a prolonged time if not permanently. The eugenic and anthropological value of this is self-evident.

REASONS EXPLAINING THE LARGER AVERAGE NUMBER OF CHILDREN BORN TO COUNTRY WOMEN

The reasons explaining the larger average number of children born to country mothers are of two classes: (1) biological; (2) social or psychological.

BIOLOGICAL CAUSES

Herbert Spencer believed that as civilization increased the reproductive capacity of the human species decreased. If this were true one might explain the whole difference between the city and the country, as regards the size of families, by saying that the city has a higher civilization than the country and consequently the reproductive capacity of its inhabitants is lower. But Spencer's dictum is not yet accepted by biologists. No definite proof has yet been discovered that the inherent reproductive capacity of man is affected adversely by the more complicated social environment of the city as compared with the country. What appears to the writer to be the nearest approach to proof of Spencer's position—the fact that many women cannot conceive although physicians can discover no definite cause of this inability—is generally explained, by the physicians themselves, as due to the fact that these women probably use all their vitality in some other way. It is supposed that excessive fatigue and nervous debility may so reduce a woman's vitality that the organs of reproduction will not function properly. The point of importance here is that inability to reproduce is due to some individual pathological

condition and not to any decline in racial capacity as Spencer supposed.

There are a large number of specific reasons why reproduction is impossible to some people. There are women who have malformations of the genital organs that render conception impossible. Of practically the same effect as malformations are accidents and pathological conditions of various kinds which create a mechanical or chemical obstruction in the path of the spermatozoön so that it cannot reach the egg.

In men temporary impotency may result from certain practices designed to prevent conception. If such practices are continued too long permanent sterility may possibly result. There is much disagreement among experts regarding the general effects of birth restriction upon the health and vitality of people who practice it. As I read both sides of the discussion I am convinced that those who believe birth control leads to the physical deterioration of the race are thinking primarily of the use of abortifacients; while those who contend that birth control does not harm the health of those who practice it are thinking of the use of methods which prevent conception. So far as I am able to judge from the evidence both are nearly right. Abortion and the use of crude methods of preventing conception lead to dire results while the use of the better methods of preventing conception probably have few or no harmful effects.

The combined effects of the causes enumerated above in lowering the birth rate are, however, less than those of venereal diseases. There is much difference of opinion among doctors as to what proportion of sterile marriages are sterile because one or both parties are suffering from venereal disease. There seems to be no doubt, however, that the effects of venereal diseases on the birth rate are even greater than their effects in causing sterility. This is the case because syphilis does not generally render conception impossible but renders it unlikely that a healthy or normal child will be born, while gonorrhœa spreads to the more remote genital organs of the woman, rendering her sterile. Dr. Prince A. Morrow states that "in private practice the mortality of infants born of syphilitic mothers is from 60 to 65 per cent. In hospital practice it is elevated to 84 or 86 per cent." Other investigators give even higher percentages. Certain it is that a syphilitic mother has very little chance of having any of her children live, to say nothing of having them grow into normal boys and girls. Syphilis is deadly to the race; and gonorrhœa is scarcely less so because it produces such a high percentage of sterility. About one marriage in every eight is sterile and many physicians believe that

most of these are due to gonorrhœa. Even those who estimate the percentage conservatively, believe that 40 to 50 per cent of these sterile marriages are caused by gonorrhœal infection. Dr. Morrow says: "Abstraction made of every other possible factor of sterility and minimizing gonorrhœa as a predisposing agent to the lowest possible degree, yet there must remain a vast contingent of sterile marriages which are caused directly and solely by gonorrhœal infection."

Thus it is not unlikely that about five or six marriages in every hundred are sterile as a result of venereal diseases, and several more in each hundred may produce only a single child before sterility sets in or abortion and stillbirths ensue and thus reduce the birth rate.

The question now arises as to the relative importance of these different biological causes in the rural districts and in the city. Unfortunately we have no definite data on this subject. In regard to malformations of and accidents to the genital organs resulting in sterility there would seem to be little difference between the country and the city. But the writer believes that all the other causes listed above operate more strongly to reduce the birth rate in the city than in the country. General nervous debility is more often a result of the tense urban life than of the slower and more placid rural life. Practices designed to prevent conception are far more widespread in the city than in the country. Lastly, but of greatest importance, venereal diseases are more common in the city than in the country. Just how much more common we may be able to tell when the complete reports of the Provost Marshal General for the period of the war are issued. In an indirect way the data on sterility of women collected by the Immigration Commission confirm this opinion. The percentage of women, married 10-19 years, bearing no children, was found to be about three times as great in the cities as in the rural districts. This was true of women of foreign parentage as well as of women of native parentage. If complete sterility of married women is generally involuntary, as many physicians believe to be the case, we are certainly justified in concluding that these biological causes are much more important factors in reducing the birth rate in the city than they are in the country.

SOCIAL OR PSYCHOLOGICAL CAUSES

When all due allowance is made for the fact that the death rate is higher in the city than in the country, and also for the fact that biological causes operate more strongly to reduce the birth rate in the

city than in the country, we must seek still farther to find the most important causes of the larger proportion of children in the rural districts. In the writer's judgment the social forces operating in a community are the most important causes determining the birth rate. They are the forces moulding and shaping the attitude of mind. They determine the aims and purposes of the men and women of the community.

In order to understand these forces which underlie the attitude of people towards the rearing of children, it will be necessary to divide the population into several classes. I have divided the city population into four classes on the basis of family incomes because I believe that the different social conditions for these four classes lead to different attitudes towards bearing and rearing children. Consequently the extent of voluntary control of the size of the family varies in these different classes. These four classes are: (1) The poor, those having an income of less than \$1,000 to \$1,200 a year. The class is composed chiefly of unskilled workers; (2) The comfortable, those having an income of from \$1,200 to \$2,200. Most skilled workers belong to this class, also many people engaged in mercantile and commercial pursuits; (3) The well-to-do, those having incomes ranging from \$2,200 to \$6,000 or \$7,000. Most professional men and men in executive positions in industry and commerce belong to this class; (4) The wealthy, those with incomes of \$7,000 or over. Capitalists and those on the road to become capitalists belong to this class. (These income limits are purely arbitrary and not too much importance should be attached to them. Obviously, many people belong to more than one class during their lives.) The rural population will be treated as a single separate class.

THE INFLUENCE OF RELIGION ON POPULATION GROWTH

Before proceeding to a study of the forces operative in these different economic classes it will be well to inquire briefly into the influence of religion upon the birth rate, inasmuch as religion knows no class lines. Protestantism has concerned itself but little with this matter and its influence is practically negligible. Protestant churches may not sanction birth control but the subject is rarely discussed by their ministers either in public or in private and the opinions of the ministers, if expressed, would have but little influence. The overwhelming majority of Protestant people consider such matters as their private affairs and would brook no meddling by the clergy. In

the Roman Catholic church, on the other hand, if one can put credence in common reports, the priests frequently exhort their parishioners (chiefly in private) to use no means to restrict the size of their families. How closely this advice is followed it is impossible to tell. Even a comparison between the size of families of Catholics and Protestants would not enable us to draw any definite conclusions. It is altogether likely that Catholics, as a group, have larger families than Protestants but it does not follow that their religion is the cause. A large proportion of the Catholics in America belong to the poorer classes (recent immigrants) and this rather than their religion may be the cause of large families. After some years of observation I am inclined to believe that as Catholics pass into the upper classes the size of their families is determined by the same social forces as are operative among other members of these classes and that well-to-do Catholics do not have larger families than the well-to-do among the Protestants. The Jews, like the Catholics, are generally supposed to be greatly influenced by their religion to raise large families. Again my observation leads me to believe that it is the economic and social status of the individual Jew rather than any general religious attitude that determines the size of the family. In my judgment, therefore, in the United States religion is not a very important factor in determining the birth rate. It serves only to assure some of those who would have large families anyway that they are doing what is pleasing to the Lord.

THE POOR CLASS

In the first class there is but little voluntary limitation of the size of the family. The two most important reasons why this is the case, are: (1) The people in this class do not know how to limit their families, (2) they do not care a great deal about limiting them, because they do not feel the burden of a fairly large family as keenly as people in the higher classes.

There can be no doubt that the poor would practice voluntary limitation of families much more than they do if they knew how. But as yet the laws forbidding the dissemination of such knowledge are quite successfully enforced against the poor. (In my judgment this is the only class of the population which the laws prevent from securing this knowledge and they bid fair to become ineffective even against them in a short time.) They have only been effective this long because this class depends largely upon free agencies for such medical attention and nursing as it secures, and because the members

have no personal friends among doctors, nurses and others, who might tell them how to limit their families.

I believe, however, that even if the poor knew how to limit their families as generally as members of other classes, they would not put their knowledge into practice to the same extent. It is the customary thing among the poor to look forward to the economic aid of the child as soon as he or she can be put to work. In the sweating industries mere babies often add their pittance to the family income by "helping mother" with her work. Even where child-labor laws and school laws are well enforced, the parents can count on the aid of the children as soon as they are fourteen or fifteen years old. Not only does the child of poor parents cease to be a direct burden upon the parents very early, but there are usually several years in which it contributes more than its "keep" to the family income. Thus a family of four or five children may render the parents substantial aid for ten or fifteen years or even longer. The parents very generally expect to get back the cost of the child before it strikes out for itself and they usually succeed. It may seem to many people that this attitude towards children is exceptional and is not a very important factor making for large families. I feel certain, however, that this attitude towards children is very general among poor people. The parents themselves were brought up to expect to go to work as soon as they were able and they expect the same of their children. The experience of those who have to do with the enforcement of child-labor laws shows that people in the poorer classes want their children to leave school and go to work at a very early age and that the children are quite willing to do so. This is the usual attitude of poor people the world over. Hard conditions of life and simple forms of work make it necessary and possible for children while yet very young to help their parents and it is customary for them to do so. Old-world ideas brought over by the immigrants also work in the same direction. The peasant economy of Europe has a place for the labor of the child and only too often the immigrants see no reason why the child should not go to work as young in this country as he would in the old country.

Many times the child begins to assist the parents at their work long before it is permitted to work regularly. It can do this quite easily, because both men and women do unskilled work. When the time comes that the child can leave school, it finds comparatively little difficulty in getting the same kind of a job as father or mother or a similar one. Children whose mothers work at home in the sweated

trades can acquire all of the skill needed to do any of the work by the time they can leave school. When the boys are too big to work at the sweated trades they are able to go to the wharves with their fathers or do rough labor on construction work or any other of a thousand jobs which require no special preparation.

I would not imply that boys and girls in this class always do the same kind of work as their parents, but I do believe that the great majority of them do work of the same general nature. I should say that the boy whose father is a longshoreman and who himself becomes a deliveryman is staying in the same general class as his father. Similarly the boy who does the unskilled labor in a new subway is following in the steps of his father who is the janitor of a tenement. We are too apt to forget that only a small proportion of children can ever rise from the general class into which they are born.

I have many times been amazed at the utter lack of ambition among the children of unskilled laborers. But when one canvasses the situation carefully, one finds nothing in this attitude of children to cause surprise. They have been brought up to expect to go to work at an early age, their parents never tried to instil into them the desire to better their lot. They have attended schools where no mention was ever made of occupations open to them, or if occupations of different kinds were brought to their attention, no efforts were made to inspire in them a desire to get into better occupations than those of their parents, and they have not been prepared to enter such occupations if the desire for them was implanted. In a word, everything in the life of the child of the poorer classes tends to press it into the mode of life of its parents while almost nothing urges it to a different mode of life.

There are forces at work now, however, which seem to me to be bringing about a change in the attitude of parents in this class towards their children, and also to be breaking down the passive acceptance by children of the rôle chosen for them by their parents. More stringent child labor laws, better enforced, are making the children dependent upon their parents for a longer time and thus rendering it less economically advantageous for them to have relatively large families. Going hand in hand with the movement to prevent too early work among children is the movement for vocational guidance and occupational training. In so far as these movements arouse ambition in the children of the poorer classes and supply the training to help them realize their ambitions, we may expect to see them

become less and less an economic asset to their families. As this takes place, there is not the least doubt but that the birth rate will fall.

It may well be that the effects of these movements on the birth rate in this class will not be very marked in this generation, but they will be in the next. Those who have themselves risen from the poor class will want to maintain their new standards and give their children at least as good a start as they themselves had, and those who wanted to rise, but were unable, will hope that by having only a fair-sized family they can give their children such advantages that they can rise. Thus the effects of better education and a longer period of childhood and preparation are certain to bring about a reduction of the birth rate.

It is not likely, so far as I can see, that the poorer classes will ever have as low a birth rate as the other classes. There will always be those who must do the unskilled work of the community and their children will, for the most part, take their places with the minimum of preparation allowed by law. Under such conditions the children of this class will naturally cease to be an expense to the family sooner than the children of the higher classes, and they will be able to add something to the family income for several years before striking out for themselves. Thus in spite of greatly improved conditions children will always be more valuable economically to the poorer classes in the city than to the other classes.

Another reason why I do not believe that the birth rate of the poor class will ever fall as low as that of the higher classes is that the poor class will always contain a greater proportion of improvident ne'er-do-wells than the other classes. People who never look to the future, who make no plans for their own lives, who care little what becomes of their children, will always have large families. No matter how widely the knowledge of birth control may be disseminated people who are shiftless, improvident and perhaps sub-normal will never restrict the size of their families to any appreciable degree.

In this class marriages take place at an earlier age than in the other classes. The unskilled laborer reaches the age of full earning power by the time he is twenty years old and will draw his highest wages between that time and the age of forty-five. This means that he can reasonably expect to care for a family at a much earlier age than the men of most other classes. The woman of this class, therefore, marries relatively early and has more years in which to bear children than the woman of any other class in the city population. Divorce, too, is less

frequent in this class than in the others. This adds to the average length of the child-bearing period of the woman of the poor class.

In spite of the fact that all these things tend to keep the birth rate of this class high its rate of natural increase is not so high as might be supposed for its death rate is high, as has been shown above.

THE COMFORTABLE CLASS

In the second class, voluntary limitation of the family is widely practiced, though it is by no means universal. There are many people in this class who look upon their children in much the same way as those in the first class. In so far as this is the case, there is no need to dwell upon the motives at work. But there are also many influenced by motives that lead to the desire for a small family.

The skilled laborer who believes in the restriction of output and in the limitation of union membership can readily see the advantages in limiting the size of his family. If it is a good thing, from his standpoint, to control the amount of labor available for doing certain kinds of work then it is a good thing not to raise more children than he can find places for in his own trade or other trades of the same grade. A great many skilled mechanics have small families for no other reason than that they believe this the most effective method of restricting the amount of labor and therefore of raising wages.

Many other people in this class raise small families because they hope to be able, thereby, to give their children better opportunities to rise into the higher classes. Many and many a family can be found among skilled laborers and clerical workers putting forth its utmost efforts to give at least one of the children a better start than its father had. In such cases, the child instead of becoming an economic asset at fourteen or fifteen years of age becomes an increasingly heavy economic burden in the years after he leaves the common school. Not only is the child a charge for a much longer period, but in the degree that the parents are successful in launching him upon his career in a higher class, they must expect to forego any return on their investment, for it takes so long to attain even a moderate degree of financial success in these higher classes that parents seldom live to see their children achieve it.

Of equal effect with ambition for one's children in causing restriction of the size of the family is ambition for oneself. There are many men in this class who feel that children would be a hindrance to them in attaining a higher position. There are also many women who have

social ambitions or who desire to continue their work outside the home after marriage. In either case children are not wanted and voluntary limitation of the family is practiced. Since, however, personal ambition, incompatible with the raising of a fair-sized family, is much more common in the third class than in this, I shall not discuss it further here.

The lack of training for women in homemaking, which is so prevalent among all classes of city women, perhaps, shows its effects most markedly in this class. The girls usually leave school after they have finished the grades or early in their high-school course and work for several years in factories, stores or offices before they are married. The work they do is very largely unskilled and requires little thought or close attention. In many factories they repeat a single simple process over again and again until it becomes purely mechanical. In the stores only a few ever learn more than the simple mechanical parts of salesmanship. Even in offices as stenographers and filing clerks, their work is but little less mechanical than in factories and stores. In any event the work of the girl who expects only to work until she gets married very seldom offers much opportunity for her to develop responsibility, self-reliance or foresight. Instead of preparing girls for homemakers, such work as they do induces careless habits and an indifferent attitude towards work of all kinds which is demoralizing in the extreme. These girls never learn to regard work as the normal and proper condition of life. They do not know what it means to find work interesting and to put the best of themselves into it. They rather come to regard work as a necessary evil to be endured for a given length of time daily either because they must work to live or because they need the money to have a good time outside of working hours.

The girls are not primarily to blame that they so regard their work. The organization of our industrial system is such that most girls never get a chance to do work that is interesting to them nor do they ever have their attention called to the opportunities for self-expression in their work. It is not the least surprising, therefore, that these girls have never developed the qualities which make a successful and happy wife and mother. Such qualities as patience, economy, foresight, good taste and adaptability—essentials to a happy life under all conditions—are not to be acquired with the taking of the marriage vows; they must be developed slowly through the years. In my judgment the work of these girls not only does little to help them develop such qualities, but often actually aids in developing other

traits of character which unfit them for home life, *e.g.*, carelessness, shirking, selfishness, irresponsibility and vulgarity. The woman who looks upon her daily life in the home as she looked upon her day's work in the factory or store before she was married is quite certain to find little there which will compensate her for raising a family. When this attitude towards the home exists, when all the good things of life are thought to lie outside of the daily routine of home life, family limitation will be practiced if the woman knows how.

Although the birth rate in this class is considerably lower than in the first class I believe that the rate of natural increase is not much different, for the death rate is also lower. But it may well be that in recent years with the improvement of the public health agencies administering to the poor the rate of natural increase of the poor has come to exceed that of this class. Unfortunately we have no very conclusive evidence on this point.

THE WELL-TO-DO CLASS

In the third class voluntary restriction of the size of the family is almost universal. In addition, late marriages and celibacy contribute to a very low birth rate. The motives leading to late marriage and celibacy do not need much special attention because they are the same, in general, as those leading to the rearing of small families among those who are married. It may be that the ease and comfort in which both bachelor men and women can live in the cities are motives which of themselves lead many to forego marriage, but I believe that ambition in various forms is the most potent motive leading to celibacy, as it is to family restriction.

Most professional and managerial positions offer abundant opportunities for advancement to capable, wide-awake, energetic, men and women. Honor and wealth are the rewards of diligence in these positions. The ambitious young man who goes into business hopes soon to leave the well-to-do class and join the wealthy as do many who go into the professions. There are many others in the professions who do not care to leave this class, but rather who are ambitious to gain recognition through scholarly or artistic work, which is more dear to them than wealth. In either case—in seeking honor or wealth, or both—personal ambition is the dominating motive in life and has a great deal of influence upon the size of the family raised.

The young man in business who sees vistas ahead in which he may exert power through wealth has little time or inclination to give himself

to his family. He may be quite willing to meet the expenses of a relatively large family; but he is so immersed in his work that he is likely to forget to be human. He probably expects his wife to shoulder the entire burden of worry and care at home, so that he will not be distracted from his work. The wife soon becomes weary of bearing her burden alone and is ready to take measures to prevent it from becoming greater. So it is that the ambition of the father lies at the basis of family restriction in many cases.

Again the father may feel that he needs all the money he can possibly save to further his business plans and so takes means to prevent the coming of children. He often feels also that he will be hampered in his freedom of movement by even a fair-sized family. Then there is always the element of chance in business, and a man may not be willing to give hostages to fortune until he can be reasonably sure that he can redeem them. In the professions the situation is much the same; with the exception that the goal is more often recognition of some kind than mere wealth. Better than wealth to a lawyer may be the appointment to the Supreme Bench, better than wealth to a physician may be the discovery of some new means of aiding mankind, better than wealth to the engineer may be the successful completion of some public work, *e.g.*, a Panama Canal, better than wealth to the scholar may be the writing of an essay which will inspire good thoughts and noble ambitions in his fellows. But the way to success in the professions is slow and laborious, and even a moderate-sized family may make the ascent much slower and more difficult.

There are also numerous cases in this class in which the man marries so that he may increase his acquaintance among men who may be of help to him through the social activities of his wife. Many such marriages are childless, while many more have only a single child.

It is quite likely, however, that only a small proportion of the women who spend much of their time and energy in *social life* do so with the object of furthering their husbands' interests; most of them have social ambitions of their own. The care and expense of even a single child will seriously curtail the social activities of a woman of this class and so, many times, children are sacrificed to social ambitions. Children tie a woman to the home rather closely for a good many years if she gives them a true mother's care. They are also expensive. No doubt the woman in this class very often has to make a choice between another child and some cherished object which will further her social ambitions. An automobile, a new home, new furniture or

more expensive clothes will each and all enhance one's social position and keep one before the attention of one's friends, while another child will withdraw one from their attention for a considerable time and make it more difficult to appear so well in their eyes. Only too often the temptation of the easy and immediately pleasant way out overcomes them and they shirk the real duty of a woman.

Like the mistreated or untrained of the lower classes, women of this class who "go in for" social life see no satisfaction to be derived from the daily routine of the home. The dearest objects in life lie elsewhere. Nowhere among their friends and acquaintances do they encounter any disapprobation of the frivolous, meaningless lives they are leading, for they are all of a feather. If it is to women of this type that the charge of parasitism, so often heard now-a-days, refers, it is very largely justified.

Again there are many women in this class who want a "career." They want to be independent economically and socially. Some of these women do not marry, but more of them do marry, although relatively late. Of those who do marry, many regard their work essential to the highest self-respect and self-development and therefore find no place in their lives for the bearing and raising of children. Happily there is a reaction, in late years, from the extreme type of feminism prevalent about a generation ago, which taught that for a woman to be dependent on a man for support was disgraceful and not to be tolerated by any woman of strong character.

But by no means are all the women of this class of the type that would prefer not to have children. The majority, without doubt, are women who find a satisfying existence in simple home life. But even such women do not desire large families, for they find the raising of children in the city a task of ever-increasing difficulty. The results of a recent investigation will show the correctness of these statements. The *Delineator* for October, 1919, published the results of a questionnaire sent to the graduating classes of a number of women's colleges. To the question: If you follow a professional or business career, would you attempt marriage and motherhood in addition, if you met the right man? 235 replied, yes, 302 replied, no, and 26 said they would attempt marriage but not motherhood. To the question: Provided you could not have both marriage and a business or professional career, which would you sacrifice? 522 replied they would sacrifice a career, 51 that they would sacrifice marriage and 22 were undecided. To the question: How many children do you want?

the replies were: None—10; One—4; Two—76; Three—163; Four—179; Five—55; More than five—63.

As I have watched the child life of the cities, especially among this class of people, I have often wondered that they tried to raise children at all. Children are not wanted in most apartment houses in desirable sections of the city, nor will single houses be rented to families with children if those without can be secured. Open places for play, close at hand, are generally lacking, while a private yard where one's children hold undisputed sway is almost unknown. Thus the naturally venturesome spirit of youth has no place in which to express itself in ways useful to the child and not troublesome to others. On the other hand, the opportunities to get into mischief seem to be unlimited.

Our cities today seem to be organized for the repression of the natural life of the child rather than to encourage its normal expression. *Don't! Don't! You must not! Get out of the way! What are you doing here?* are apparent everywhere, while, *Come on! Take part! Enjoy yourself! Here is a place for you!* are scarcely visible anywhere. Because of these conditions it is not unlikely that, in this class where standards of living are high and income not sufficient to permit of much help in the home, one child causes more work and worry than several in the lower classes.

But aside from the care and expense of raising children while they are comparatively young, parents in this class generally have to provide for their children for a much longer period than those in the lower classes. At the age the child of the poorer classes begins to be self-supporting the child in this class begins to make greater demands upon the economic resources of its parents. Prevision and foresight are well developed in these people and consequently they make definite plans, so that their resources will meet their own needs and provide a good start in life for their children. Expenses during high school, college, technical school and possibly even for a year or two while getting a foothold in some profession, generally strain the family resources to the limit when the family is small. Therefore a large family is not desired.

The desire for travel is another motive often leading to the restriction of the size of the family in this class. It needs no argument to show that children make travel more difficult both from the standpoint of expense and from that of leisure. Each child born increases the normal expenses of the family and makes it more difficult for the parents to take their children with them or to leave them behind

when they travel. Thus with the growth of the family the likelihood of being able to travel decreases. Therefore, where there is a strong desire to travel, a "trip" very often is chosen as the alternative to another child.

The desire to attain culture is also a motive leading to family restriction in many cases. A certain amount of leisure and freedom from harassing care are necessary to the development of a cultured personality. A large family of children or even a moderate-sized family is apt to make the work and the worry of maintaining class standards so difficult that one will have little energy or inclination for anything beyond the daily routine. The realization that this is likely to take place causes many people to raise only one or two children. They feel that the sacrifice of self-development involved in rearing more is too great.

We have no very extensive data bearing on the birth rate and death rate in this class, but such data as we have seem to justify the conclusion that there is no natural increase. My own belief is that this class does not produce enough children to keep up its numbers, but we must await further investigations before we can be positive on this point.

THE WEALTHY CLASS

There is no sharp line dividing the fourth class from the third either in regard to the motives leading to family restriction or the rate of natural increase. Family limitation is almost universal in the fourth class and ambition, in one form or another, and love of ease are the most powerful motives leading to it.

This class is quite small, comprising not more than a few hundred thousand families (judging from the federal income tax returns). The great majority of the men belonging to it are men having incomes near the lower limit. Most of these men hope very soon to increase their incomes and are struggling desperately to rise. Nowhere in our population is the competition more strenuous than between men who have attained some measure of success and whose appetite for it is, therefore, insatiable. These men are "climbers" in their lines and very often their wives are social "climbers." Thus the chief interests of both husband and wife lie outside the home and children are regarded as a burden. Such people have no real home life and do not care enough for it to stop scrambling for position. The husband only too often thinks of his wife as the means to a larger acquaintance

among people who may be able to help him along and the wife regards the husband and home merely as necessary incidents to respectability. The result is that their families almost never comprise more than two children and very often none at all.

These "climbers" have neither accumulated wealth nor do they have very assured positions in society. They have therefore nothing definite to bequeath to their children. They have no pride of family urging them to leave descendants to carry on the family name and traditions; they have no definite position in the community, which they can be assured of transmitting to their children. These people are themselves adrift, they know not whither they are bound, and many of them feel, in their more serious moments, that life is so uncertain and there is so little worth while to be got out of it that they will save trouble all around if they have no children.

On the other hand, among the wealthy, whose position is assured, there is a certain amount of pride in one's family, leading them to rear children to carry on the family name and fortune. They have not only wealth but a much-coveted position in the community which they can command for their descendants. This portion of the wealthy class probably more nearly reproduces itself than the "climbing" portion.

Undoubtedly the sheltered lives of ease and luxury led by many girls in the wealthy class and even by some in the well-to-do class disincline them to undergo the hardships of bearing and rearing a family. To a girl who has been brought up in the belief that her own whims and desires are of prime importance and that all values are to be judged by these pampered inclinations it is often inconceivable that she should deliberately do anything to bring herself pain and work and worry and probably even deprivation of some customary luxuries. Such girls brought up apart from the stern realities of life are not capable of judging values aright. They know little of the feelings and values which grow up naturally when men and women struggle side by side, help to bear one another's burdens, share sorrows as well as joys and, above all, live close to the great streams of simple, work-a-day humanity. Women whose only passion is for ease and luxury lose touch with humanity and substitute for true human values those of a small and highly institutionalized class.

It is especially unfortunate that the women of this class do not rear moderate-sized families, because they are so widely imitated by the women in other classes.

THE REASONS FOR THE HIGH BIRTH RATE IN THE COUNTRY

There is no need of dividing the rural population into classes in order to study the causes of the relatively high birth rate in the country. The great majority of people living in the country have incomes (counting what they use directly from the land) about the same as those in the comfortable class in the city. There are some people in the rural population who are really poor and there are a few who belong to the well-to-do and wealthy classes but these two extremes (not taking the negroes into account) comprise only a very small proportion of the whole. For this reason and also because I believe that all classes of people in the country, in spite of considerable differences in their incomes, think in much the way same regarding the size of their families, I shall speak of the farmer and non-farming rural population as belonging to a single class.

The women raised in the country have been trained to be homemakers. The changes which have been referred to above as unfitting many city girls to become good homemakers have not affected the country to any great extent. The country girl learns to help her mother about the home almost as soon as she can walk. There are numberless little tasks that she can do before and after school hours. If she happens to be an older child she gets training in caring for the younger children. She learns to make butter, care for the chickens, and to raise a garden as well as to cook and keep house. She never lacks for work about the home during vacations and after she has finished the country school. She grows up with the idea that her place in the world is to be a wife and mother. She never learns that the world offers almost numberless opportunities to women to do things outside the home. When the time comes for her to marry she knows what is expected of her and she is trained to the task.

The country woman who keeps house and does the work usually connected with housekeeping on the farm never needs to feel that she may be an economic hindrance to her husband as many city women must. She knows, as her husband too often does not, that she is helping to make the farm pay. Her garden and chickens and butter and her daily economies constitute a positive contribution to the welfare of the family greater, in all probability, than that of many city women who work outside the home. A farm is commonly a partnership affair on its producing side, but as in most other industries the "boss" is able to distribute the product according to his desires rather than in accordance with the principles of justice.

The fact that the woman is such a direct economic asset on the farm probably accounts for the greater proportion of married women in the country and the earlier marriages there. Both of these things help to keep the birth rate in the country relatively high.

Children, too, are generally of economic value on the farm earlier than they are in the city. There are many kinds of tasks both for boys and girls on the farm which do not injure their health but which help to keep the work going smoothly. The bringing in of fuel, the care of calves and colts and pigs, errands to and from the fields, the assistance with the garden, all can be done by boys and girls, without injury to health, outside of school hours and during vacations. Besides the boy can even help with the field work by the time he is ten or twelve and be all the better for it, so long as he does little but drive a team hitched to light machinery. He can also help with the lighter parts of the heavier chores—the care of horses and cattle. The girl in addition to her chores outside the house can be of use to her mother in the house in a hundred ways and if not overworked will in no way be injured. I am fully aware that many country children are overworked and underplayed, but I do not believe that such a state of affairs is at all general. If it is, however, it only goes to prove that country people find children more economically valuable than I have supposed they are, therefore, more willing to have good-sized families.

In the country both boys and girls work at home by the side of their parents. Because of this they very soon learn that both father and mother are working for the same ends and that they are helping their parents to attain these ends. There is thus developed a unity of interest in the family in the country which is very often lacking in the family in the city. Because of this close personal contact between parents and children while at work, there is less danger that the morals of the country children will be corrupted. I would not be understood to say that, morally, all is as it should be in the country—far from it—but there is less chance that the average country boy will become utterly good-for-nothing than that the city boy will. I am quite convinced that the fact parents and children spend much time working together in the country has a wholesome influence on the children in teaching them habits of steady application and thrift, while the fact that parents and children are together so little in the city has, in general, a demoralizing effect. This brings it about that parents in the country have less reason to fear for the future of their children and are therefore more willing to raise good-sized families.

Another way in which the unity of interest is developed in the family in the country is through the discussion of family affairs in the home. Most of the things of a local nature that the farmer and his wife are interested in can be discussed with profit before the children. From the time the children are ten or eleven years old they can understand something of the problems of farm management and household management and they are also interested in what is going on in the neighborhood. In fact, the children very often have something to contribute that is of interest to the parents. Thus the whole family grows up within the same circle of interests and every member feels that he is included in any discussion or conversation that may arise. How different is the situation in the city! The business man comes home from the office or store with weighty matters on his mind and he finds it impossible to relieve himself by talking to the whole family, or even to his wife, because the thing absorbing his attention is highly technical. He finds his wife and children talking about neighborhood or school matters of which he knows little or nothing. So the family instead of being brought into closer unity by a mutual understanding of one another's interests is divided and the members may feel rather indifferent towards one another. Modern city life seems to me to have an increasing tendency to diversify the interests of the members of the family rather than to centralize them as rural life does.

Country life, therefore, makes it easier to keep alive personal interest in human beings than city life does. Definite personal interests—interest in wife and children, interest in school and church, interest in neighbors—take up a goodly share of the farmer's thought. He does not become engrossed with entirely impersonal matters as the city man is apt to. He must deal directly and humanly with people at almost every turn, while the city man deals more and more with *things* directly and people only indirectly and technically. But even if the farmer becomes engrossed with things, *e.g.*, the extension of his acres, he yet hopes that he will have the children to help him till these new acres and to whom he can leave them, so that after all it is a family interest he is looking out for. I am quite certain that the more human and personal nature of the life of country people as compared with that of city people makes them willing to raise larger families.

Another reason for large families in the country is that it is easier to raise a good-sized family there than in the city aside from the fact

country children early become an economic asset. The "barefoot boy with cheek of tan" is to be seen wherever one goes in the open country and usually his little sister is with him. The clothes may be soiled, the faces and hands dirty, but it is usually the "clean dirt" of the open country—the mud from the creek, the dust from the road or the stain of fruit and berries—not the foul slime from the gutter which one sees on the children in the poorer parts of our cities.

The country child always has a big playground at hand. In this playground are wagons and buggies, cultivators and plows, machinery and tools, cattle and horses, all of which call for careful attention and invite to manipulation. Many are the months and even years which the child can spend in playing with things which he will later want to use in his work.

If the children are not in the farm yard at play the mother may be quite sure that they are safe wherever they are. Besides, she knows all the neighbors' children and knows whether or not they are good companions.

The dressing of the children for school so that they will look respectable is not the trying task it often is in the city. Cleanliness and comfort are the two chief standards of respectability and they may be attained quite easily in the country. Colored dresses for the girls, with big aprons; overalls and blue shirts for the boys, with black stockings and heavy shoes for both, are sufficient for their requirements, and, for my own part, I think they look very well.

Furthermore, country children do not have the continual enticements to spend money that the city children have. They do not see the gaudy display of toys and candies in the store windows on their way to and from school and, recently, the brilliant-colored lithographs of the "movies." If the country boy wants a sled he probably makes one, thus saving money and learning something useful. Country children learn to amuse themselves rather than to ask papa for money to pay to be amused and this can not fail to relieve the country mother of much worry, because while amusing themselves around the home they are not very likely to get into serious mischief. We must all agree, I think, that it costs less, in money, in work, and in worry, to rear a child in the country than in the city, and for this reason country people are more willing to rear them.

Moreover, the relatively secure economic position of the farmer makes him and his wife more willing to raise a good-sized family. The industrious farmer, either renter or owner, is practically certain

of a fair living. Panics and hard times do not affect him as they do the industrial worker. Dissatisfaction of the capitalist manufacturers over a new tariff schedule does not throw the farmer out of a job nor render his living precarious, as it may the city worker. In fact the farmer is more or less immune from the most of disturbing conditions connected with modern industry. Of course, he occasionally loses a crop. But now-a-days when the farmer raises a number of different crops he very seldom has a total failure in all of them. For these reasons a farmer does not need to worry whether he will be able to feed and clothe his family, as many men in the city do. He can be practically certain that he will be able to meet the ordinary exigencies of life without a great deal of hardship to himself and his family. Because of this feeling of security of position the farmer has less reason than the city man to feel that he is giving irredeemable hostages to fortune when he has a large family.

We have seen that in the city many people limit their families because they feel that they can not otherwise give their children the best opportunities. This motive to family limitation has very little influence in the country. The farmer generally regards his duty to the child as fulfilled if he allows him to complete the country school. He is quite sure that the boy who amounts to anything can shift for himself if he has a common-school education and has learned habits of steady application.

In the environment of the country most farmers come to believe that the schooling which was good enough for them is good enough for their children. Only a few make plans for the better education of their children which involve saving and preparing years ahead. This is not because the farmer does not want his boy and girl to have as good opportunities as other boys and girls, but rather because the only opportunities he knows about are on the land and he does not see how an expensive education can help the boy to raise better crops. The average farmer little realizes how many opportunities are open to the young man with a good education which are closed to the one with only a common-school training because he does not realize the growing complexity of modern life. Therefore the farmer finds no reason to limit his family in the hope that he may thereby be able to give the smaller number of children an expensive training for their life work.

In the past, too, the farmer has known that there were good opportunities farther west if his family was too big to settle on the home place, and so he felt little anxiety over the future of his children.

Even when the boy prefers to go to the city rather than to go west the farmer feels little doubt about his ability to compete with the city boy. He firmly believes that his boy can take care of himself wherever he may go. He also knows that the boy who works at home until he is twenty or more years of age owes him little economically for his "keep" and he does not feel that either his situation or the future of the boy would be much changed by rearing a smaller family.

THE OUTLOOK FOR THE FUTURE

In the opinion of the writer there is little danger that the newer immigrants will supplant the older stocks by any natural process of population growth. If they supplant the older stocks it will be because adequate restrictions are not placed upon their entrance into this country. The future racial constitution of this country can be determined by prompt adoption of simple legislative enactments for this purpose. If, however, nothing is done and matters are allowed to proceed as in the past, the situation may soon be beyond control. Should the time come when our whole population of Nordic stock is subjected to the same severe competition with immigrants as our city population has been for some time past, no amount of legislative action or exhortation will prevent the rather rapid conquest of the United States by peoples from southern and eastern Europe.

General Walker long ago pointed out the fact that our population growth, as a nation, had been influenced very little by immigration. He believed that the competition of immigrants with older stocks so reduced the birth rate of the latter that the immigrants just about made up the loss. There can be no question that the opportunities which people see for themselves and their children to gain a good living determine the size of families to quite an extent. Since native men and women have seen less and less opportunity as competition with immigrants increased, and even a moderate amount of ambition has led them to restrict the size of their families until the older stocks in our cities are dying out. Ambition of country people has been more moderate than that of city people and the opportunities they coveted for their children have not been subject to the same competition from other groups and so the native stock on the farms has gone on increasing at a good rate.

At present most of our large cities are peopled by stocks different from the prevailing stock of the open country. The city people are an amorphous mass of humanity whose purposes and aims are not

understood by country people. Nor are the farmers understood by the mass of city dwellers. These groups are mutually suspicious. They have no common historical background and few common aims and purposes. The suspicion and distrust of one another feeds upon social differences and mutual lack of understanding. Just how much of this suspicion and distrust is due to racial differences and how much to the natural antagonism of agricultural and commercial and manufacturing interests, I shall not attempt to say. I believe, however, that the different racial elements in these groups make mutual understanding more difficult and may lead to some rather serious consequences when both groups become better organized. If immigrants are allowed to come practically without restriction, as before the war, the racial differences between these groups will become still more marked and the possibility of misunderstandings thereby increased.

THE EUGENIC SITUATION

From the standpoint of eugenics the effects of our present population movements merit careful consideration. Is it eugenically desirable that our population should continue to increase most rapidly in the country and in the poorer classes in the city, while the well-to-do and wealthy classes increase very slowly if at all? In what ways, if any, is this process leading to a survival of the unfit?

Our rural population, as a whole, is of good eugenic value. The people are hardy, energetic and of good habits. Their hereditary capacities are in general good and sound. Their average of ability is high. I am well aware that there are many biologically degenerate families and neighborhoods in the country but they form only a very small proportion of the total rural population. Aside from these biologically inferior people, who should be prevented from propagating their kind, the relatively rapid rate of increase of the rural population is eugenically desirable because it adds a large increment of good stock to our population year by year. Certainly, so long as the increase of our population comes most largely from the country we need have no fear that the quality of the stock is deteriorating.

The poorer classes in the cities are also of good stock although, in my opinion, they contain a slightly larger percentage of hereditary degenerates than the rural population. Poverty is not, as so many are accustomed to think, *prima facie* proof of inferiority. In most cases it is a result of lack of opportunity rather than of lack of ability. In the very nature of the case, however, the percentage of those who

lack ability is larger among the poor than among other classes. The indolent, the incompetent and the good-for-nothing drift into the poor class as naturally as a stone sinks to the bottom of the pond. The question of the mental capacity of our recent immigrants who belong chiefly to this class is one which I cannot discuss here. I wish to say, however, that no convincing proof has ever been offered to show that they are essentially inferior to the older stocks. Moreover, I have never found a person knowing any group of them well who does not believe that they are of sound stock and of good average capacity. It seems to me, then, that this class, as a whole, may be said to be of good heredity and that we need not fear deterioration of our population because of its relatively rapid increase.

It should not be forgotten, however, that there is a certain small percentage in this class that is biologically unfit. The people in this small group constitute a menace not only to the standards of the poor class, but also to the well-being of the whole community and consequently should be treated as wards of the state and should be segregated so that they cannot propagate.

The real hereditary degenerates of the nation are found chiefly in the rural population and in the poorer class in the city. So far as can be judged from numerous special studies these unfit are increasing at a rather rapid rate, although not as rapidly as the normal members of these classes. Year by year the number of incompetents who cannot be raised to normal conditions of living by the improvement of their environment is increasing. Thus we find a steady absolute, if not relative, growth of the lowest stratum of the population. Contrast this with the situation found at the other extreme—among the well-to-do and the wealthy.

In the upper economic classes there is no natural increase of population, but in all probability a decrease from year to year. It was shown above that the graduates of women's colleges were only rearing about enough children to replace themselves, to say nothing of their husbands. There is very good reason to believe that this is true of the upper economic classes as a whole. These classes contain a high average of ability. Most men who belong to them have risen from a lower economic class. They have proved by their rise that they have more of certain kinds of ability, on the average, than other members of the classes from which they rose who had equal opportunities. They have shown adaptability, energy and initiative above the mean.

It may be objected that many are born into these classes and there is no proof that they have more than average ability. The latest developments in our knowledge of heredity show us that the hereditary qualities of people pass from generation to generation with but little change. The cases of the children of the wealthy who do not amount to anything furnish no proof that they do not have good capacities. They merely prove that their training, perhaps their health, and the environmental influences by which they have been surrounded, were bad and unwholesome. I recall reading in Montaigne the opinion that princes usually learned nothing well except the management of horses. He explained this as due to the fact that the people about them always flattered them and gave way to their caprices and required nothing thorough of them, while horses made no distinction between princes and commons and consequently they were forced to learn the management of horses thoroughly. The children of our upper classes are much like princes. They are seldom subjected to adequate discipline and it is rather a wonder that so many of them turn out well than that many are utterly useless. I think there can be no serious doubt of the fact that the members of the upper classes, whether they have risen into them through their own efforts or were born into them, have a somewhat better heredity than the average of the population.

It should be remembered that we are considering the average of ability in these upper classes, for there are no doubt in them individuals of very ordinary capacities and some few who are biologically degenerate. There are those who become members of these classes by the merest chance, having no merit of their own entitling them to distinction of any sort. Then there are those whose financial success is due to certain qualities—callousness, ruthlessness, indomitable ambition for wealth, selfishness, greed and brute force—who should not, in the interest of the general welfare, be in positions of importance and power. But in spite of the presence of many people in the upper classes who are of very ordinary capacity I believe that the average of ability in these classes is somewhat higher than in other classes.

If this is true, then it is a very serious matter that these classes do not reproduce themselves. One objection often raised to a democratic country is that the breaking down of class lines is likely to lead to the depletion of the best stocks. It would seem that this is now happening in the United States. We pride ourselves on the fact that people with initiative, energy, ambition, imagination and good minds can rise

from the most humble conditions to positions of wealth and influence in the upper classes. This very ease of rising tends to extinguish much of our best ability in a single generation. A man from the poor class, with no family traditions to uphold, and therefore, with no concern for the future of his own family, struggles to rise. He succeeds in attaining wealth or prominence or both. He has not more than three children at most and often none. His family soon dies out and his ability is lost to the nation. This process is going on with great rapidity at the present time and in my judgment is the most serious phase of race suicide. However large the supply of excellent ability in the lower classes from which the upper classes may draw, this process of obtaining leaders cannot go on indefinitely without weakening the nation.

In view of what has been pointed out above I would take issue with those who believe that the rate of increase of the nation, as a whole, is not sufficiently large—who believe that a more rapid rate of population growth is all that is needed to prove that our people still possess the vigor of their ancestors. There is no doubt in my mind that our population is increasing as fast as it can be provided with the means of maintaining a good standard of living. It is a serious matter, however, that the lowest class, the biologically unfit, is steadily increasing while the better stocks are dying out. If the upper classes were to raise fair-sized families—four or five children—the national birth rate would be raised but slightly and yet the good capacities and abilities of these people would be saved to the nation. There is little doubt, moreover, that if the children of these classes were raised in fair-sized families they would get better training and discipline for life than they now do.

What can be done to encourage the upper classes to raise fair-sized families? Certainly nothing can be done by legislation. Birth control has come to stay and bounties for large families will only be accepted by the improvident—the very class which should not be encouraged to raise a numerous progeny.

A general hue and cry about our low birth rate will be of no effect. The problem is one of developing standards of life in the upper classes which are not incompatible with the raising of a family of four or five children. This will involve a simplification of present standards. There is neither time nor energy for good home life and all of the external activities now engaged in by people of these classes. The raising of a family of moderate size involves a choice of a home life

with much unobtrusive sacrifice in preference to a life with a large amount of personal gratification and a minimum of responsibility to others. Certainly the choice of the former requires some fortitude when one belongs to a class where the latter is regarded as the only normal life. If any great change is to be wrought in the habits of the upper classes it must come from the examples set by those who believe that life is a serious matter and should not be frittered away in doing solely those things which make for their common personal gratification. If any considerable number of wealthy people so conducted their home life and their business affairs that other members of the upper classes were convinced of their serious moral purpose, they would imitate them and we should have little need to deplore the dying out of our better stock.

Along with the return to a more simple life we need to develop a just pride of family. We probably cannot go very far in this direction until we are more mature. A family must have back of it some generations of solid achievement and a well-developed tradition before pride in it will be a powerful motive leading to the rearing of children. A young people living in an age when all things seem transitory will have little of the better sort of family pride. Such as we have is often arrogant and is scarcely more than snobbishness. This has led many earnest people to feel that concern about one's family—past or future—is undemocratic. But we shall probably never get the best out of the people in our upper classes—biologically through their children and socially in direction of national development—until they do develop a just pride in family. So long as one is thinking merely of himself and the swath he can cut in the present generation his best energies are quite likely to be directed to the accumulation of the tangible evidences of his success and to the display of these in a conspicuous manner. In such a scheme of life children are more or less of a nuisance and consequently are shunned.

If, after the present standards of the upper classes have undergone a simplification and a just pride in family has developed, there should prove to be any considerable number of people in them who will not participate seriously both in the life of their own day and in that of the future, through the raising of children, it is perhaps just as well that they should die out. Certainly such people will be failures in a larger social sense as well as biologically and they probably would have nothing to contribute to the progress of mankind. One may look upon the dying out of those who worship the God Mammon as

nature's kindly provision for ridding the world of the over-ambitious, egotistic elements who have missed the true goal of living.

SUMMARY

A study of the population movements in the United States shows that the older stocks (Teutonic) are dying out in many places and are being supplanted by the newer immigrants. In Massachusetts, Rhode Island and other states in the northeast this process of substitution has already gone very far. In some classes, *e.g.*, graduates of women's colleges, deaths are almost twice as numerous as births. A comprehensive view of the situation throughout the nation shows that it is chiefly in the cities the old stocks are not holding their own. City life seems to be unfavorable to the raising of even moderate-sized families among all except the poor.

In the rural districts, on the other hand, children are numerous and the rate of natural increase is much in excess of that of the urban districts. If it were not for immigration a few generations would find most of our city people tracing their descent back to the rural population of today. This would, no doubt, greatly simplify our population problems of the future for the rural population of today is largely of old (Nordic) stock.

The rural population has a higher rate of increase than the city population, (1) because it has a lower death rate, and (2) because, on the average, the women give birth to more children. The death rate is lower in the country because of its generally superior health conditions. The families of country people are larger than those of city people both because they want more children, consequently practicing birth control less, and because involuntary restriction is a less important factor in the country.

If one divides the city population into four classes: the poor, the comfortable, the well-to-do, and the wealthy, he will find that the last two classes almost universally limit the size of their families voluntarily where involuntary sterility, due to venereal diseases and other biological causes, does not render this unnecessary. In the comfortable class voluntary restriction is quite common but in the poor class it is little practiced.

Thus race suicide becomes a problem in eugenics and anthropology. Is it desirable to have our natural population increase come chiefly from the rural districts and the poor class in the cities? Although the vast majority of people in these classes are biologically sound yet

most of the biological degenerates in our population also belong to these two classes and at present they are propagating almost as rapidly as the sound stock. The upper classes—well-to-do and wealthy—probably do not propagate themselves, to say nothing of adding to the population. These classes contain much of the best ability in our population. To have them die without leaving fair-sized families is a serious matter. It means that much of the superior ability of the nation is used up in each generation. Able men and women rise into these classes and fail to propagate, thus eliminating their superior qualities from the population. If this process continues for any length of time it is bound to be harmful to the nation.

The only chance of changing the attitude of the upper classes towards raising children lies in changing their standards of living. They must live more simply. Ambition, love of ease and love of luxury must be moderated and humanized before the members of these classes will be willing to raise fair-sized families. A just pride of family must also be developed among the people in these classes so that they will feel they have something worth passing on to the next generation.

The subject of the effects of these conditions on the physical standards of the American people will demand future attention.

ANTHROPOMETRY

ALEŠ HRDLIČKA

E.—OSTEOMETRY

Anthropometry of the skeletal parts (outside of the skull) is a fertile and fascinating field in which much as yet remains to be exploited and even explored. It is, moreover, a large field, which few workers may hope to cover in its entirety. Every bone of the body presents sexual, racial and individual variations, many of which remain to be thoroughly studied; and some of these features, according to indications, possess a very considerable phylogenetic and racial importance.

Investigations on the skeleton are for the most part of a more recent date than those on the skull or those on the living, and have been largely the work of anatomists. Descriptive observations, such as those on the sexual characteristics of the pelvis, or those on the perforated humerus, pilasteric femur, platycnaemic tibia, etc., preceded and accompanied measurements. The first serious attempt at osteometry was made essentially in France, and the first system of measurements was developed by Broca and his pupils in Paris.¹

Since the early seventies a whole series of valuable contributions to the subject of bone study and osteometry have been made,² and

¹ See Broca (P.)—*Sur les proportions, relatives du bras, de l'avant bras et de la clavicule chez les Nègres et les Européens.* *Bull. Soc. d'Anthrop.* Paris, 1862, III, 162-172; *ibid.*, 1867, 2 ser., II, 641-653. Hamy (T.)—*Recherches sur les proportions du bras et d'avant-bras aux différents âges de la vie.* *Rev. d'Anthrop.* Paris, 1872, 79. Topinard (P.)—*Elements d'Anthropologie Générale*, 8°, Paris, 1885.

² Bello y Rodriguez (S.)—*Le fémur et le tibia.* *Thèse*, Paris, 1909. Bümüller (J.)—*Das menschliche Femur.* *Phil. Diss.*, München, 1899. Bertaux (T. A.)—*L'humerus et le fémur considérés dans les espèces, dans les races humains, selon le sexe et selon l'âge.* *Thèse*, Lille, 1891. Fischer (E.)—*Die Variationen an Radius und Ulna des Menschen.* *Z. f. Morph. & Anthrop.*, 1906, IX, 147. Lehmann-Nitsche (R.)—*Ueber die langen Knochen der südbayerischen Reihengräberbevölkerung.* *Phil. Diss.*, München; and *Beitr. z. Anthrop., & Urgesch.* Bayerns, 1894, XI, H. 3 & 4. Livon (M.)—*De l'omoplate.* *Thèse Méd.*, Paris, 1879. Hrdlička (Aleš)—*Physical Anthropology of the Lenape or Delawares, and of the eastern Indians in General.* *Bull.* 62, *Bur. Am. Ethnol.*, Wash., 1916. Pfitzner (W.)—*Beiträge zur Kenntniss des menschlichen Extremitätens-skeletes.* *Morphol. Arb.*, 1892, I, 516; 1893, II, 93. Rollet (E.)—*La mensuration des os longs des membres.* *Thèse méd.*,

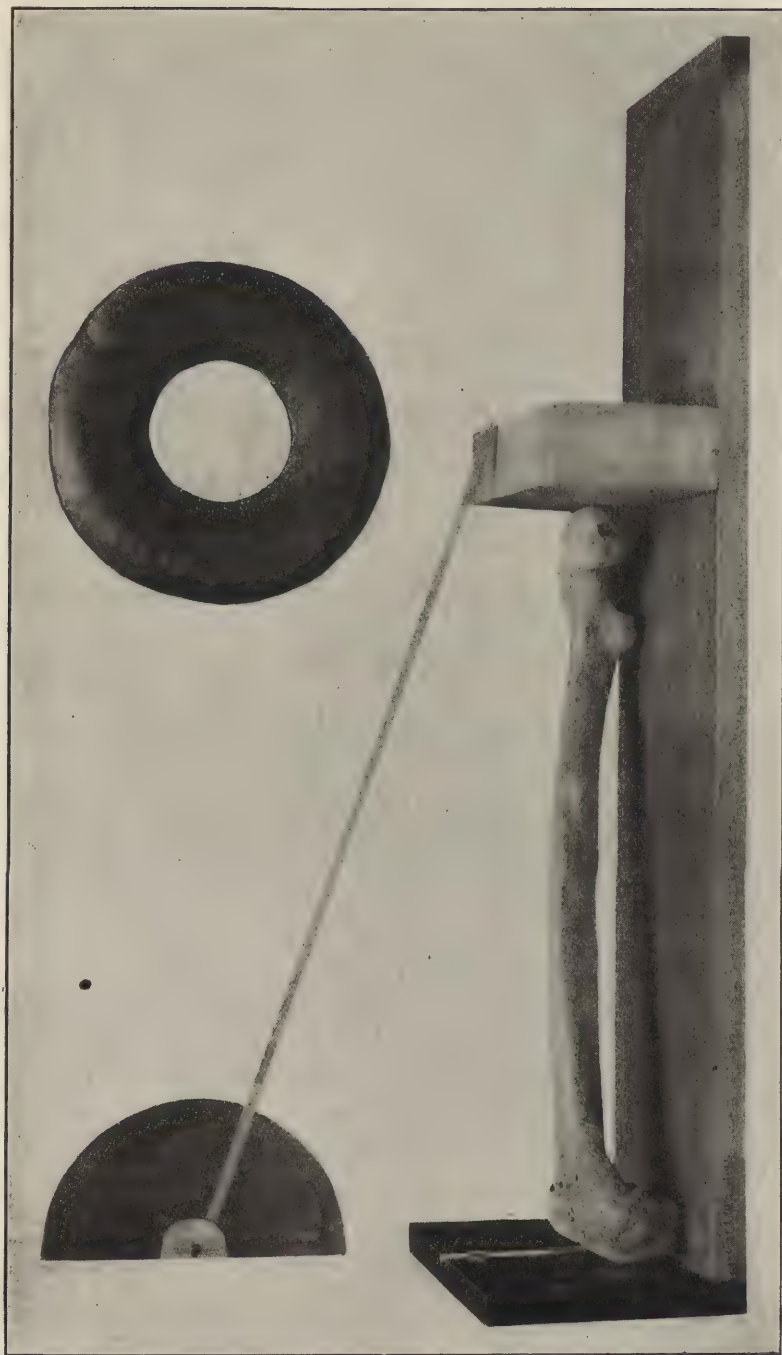
much work in this line, particularly in the United States, is as yet unpublished. The repeated discoveries of skeletal remains of early man have in particular stimulated research in this direction. Notwithstanding all this, however, we are still far from a satisfactory grasp of the evidence which the bones embody. The reasons are, in the first place, that the gathering of skeletal material has always lagged behind that of the skulls, so that even today most anthropological collections are relatively poor in that respect, which hinders comprehensive and conclusive investigations. Besides this, the bones of the skeleton present many features and correlations the study of which demands large series of specimens, and in many cases also the presence of all the important constituents of the skeleton or the bones of the two sides of the body, conditions which are realizable with difficulty even among the Whites, not to speak of other peoples. The field will long remain, therefore, one of a very considerable importance, and no pains should be spared to develop the technique of osteological examination.

The scheme here presented rests on the same principles as those presented before for anthropometry and craniometry. It utilizes the most useful procedures of other scholars, supplements these where extensive individual experience warrants, leaves aside everything superfluous or of value only in special studies, and aims at the utmost simplicity.

INSTRUMENTS

The matter of osteometric instruments has already to some extent been dealt with in the section on Craniometry (Vol. II, 1919, p. 50). The essentials are few. They are the Broca's osteometric board (pl. 1), the small *compas glissière* and for a few measurements also the large sliding compass; but other instruments may be needed for special investigations.

Lyon, 1889; *Intern. Monatschr. & Anat.*, 1889, VI, 345. Soularue (M.)—Recherches sur les dimensions des os et les proportions squelettiques de l'homme. *Bull. Soc. d'Anthrop.* Paris, 1899, Sér. 4, X, 328. Turner (Sir Wm.)—Report on the human crania and other bones of the skeletons collected during the voyage of H. M. S. Challenger, 1873–6: II—The bones of the skeleton. *Challenger Reports*, Zool., 1886, Pt. XLVII. Verneau (R.)—Le bassin dans les sexes et dans les races. *Thèse Méd.*, Paris, 1875. Volkov (Th.)—Variations squelettiques du pied chez les primates et dans les races humaines. *Bull. Soc. d'Anthrop.* Paris, 1903, Sér. 5, IV, 622; 1904, V, 1, 201. Waldeyer (W.)—Das Becken. Bonn, 1899. Wetzel (G.)—Volumen und Gewicht des Knochens als Massstab für den phylogenetischen Entwicklungsgrad. *Arch. f. Entw. d. Organismen*. 1910, XXX, 507–537.



Pl. 1. Osteometric board with block; goniometer (translucent); leather ring, for support of skulls while being measured and examined.

The osteometric board is too well known to need special description; but for the original accessory square the writer uses a block of light wood (see pl. 1), which offers certain advantages. The block is 9.5 cm. high and 4.5 cm. thick, while its length equals the breadth of the board.

For description of instruments used on special occasions the student should consult the original sources.¹

BLANKS

The matter of blanks in osteometry presents some difficulties on account of the many distinct bones each of which requires its own blank. An outline of a blank such as used for general purposes by the writer will be given separately with each bone. Such blanks may be made by the student himself, and their scope may be enlarged as demanded by the needs of the occasion. As they are they represent what invariably we should know of each of the bones.

OBSERVATIONS: TYPICAL BONE VARIANTS IN FORM

Before proceeding to the measurements, attention should be given to the important subject of bone variations in shape.

Each of the long bones, and also the scapulæ, first rib, etc., present a variety of forms which are reducible to definite types, and the frequency of these types differs from race to race. In the remainder of the skeletal parts similar variations occur, but they are less classifiable. The whole subject is of very considerable anthropological, phylo- as well as ontogenetic, importance.

In the long bones the part that varies most in form is the shaft; in the scapula it is in the contour of the bone.² Bones of less consequence will be considered on other occasions.

¹ Besides the Memoirs of Broca and the textbooks of Topinard and Martin, see: Emmons (A. B.)—A study in the variations of the female pelvis. *Biometrika*, 1913, IX, 34-57. Garson (G.)—Pelvimetry. *J. Anat. & Physiol.*, 1882, XVI, 106-134. Frassetto (F.)—Lezioni di antropologia, 1911-1913. Hepburn (D.)—A new osteometric board. *J. Anat. & Physiol.*, 1899, XXXIV, 111. Matthews (W.)—An apparatus for determining the angle of torsion of the humerus. *J. Anat. & Physiol.*, 1887, XXI, 536-8. Russell (F.)—A new instrument for measuring torsion. *Am. Nat.*, 1901, XXV, 299.

² For original reports on this subject see Hrdlička (Aleš)—Study of the normal tibia. *Am. Anthropol.* 1898, XI, 307-312; *Proc. Ass. Am. Anat.*, 11 Sess., Wash. 1899, 61-66. A further contribution to the study of the tibia, relative to its shapes. *Proc. Ass. Am. Anat.*, XII & XIII Ses. Wash. 1900, 12-13.—Typical forms of shaft of long bones. *Proc. Ass. Am. Anat.*, XIV Sess., Wash. 1901, 55-60. Also *Bull.* 62, *Bur. Am. Ethnol.*, Wash. 1916. Consult also: Manouvrier (L.)—La platycnémie

Long Bones: The form of the shaft of the long bones is best differentiated at or near the middle of the bones, in adult individuals.

Variation in these shapes is greatest in the Whites. There are considerable racial and other group differences in the relative frequency of the different types of the shaft of the various bones; no one type, however, occurs exclusively or is completely absent in any of the human groups now existing. Some of the shapes are common to the anthropoid apes, and others occur far back in the animal kingdom.

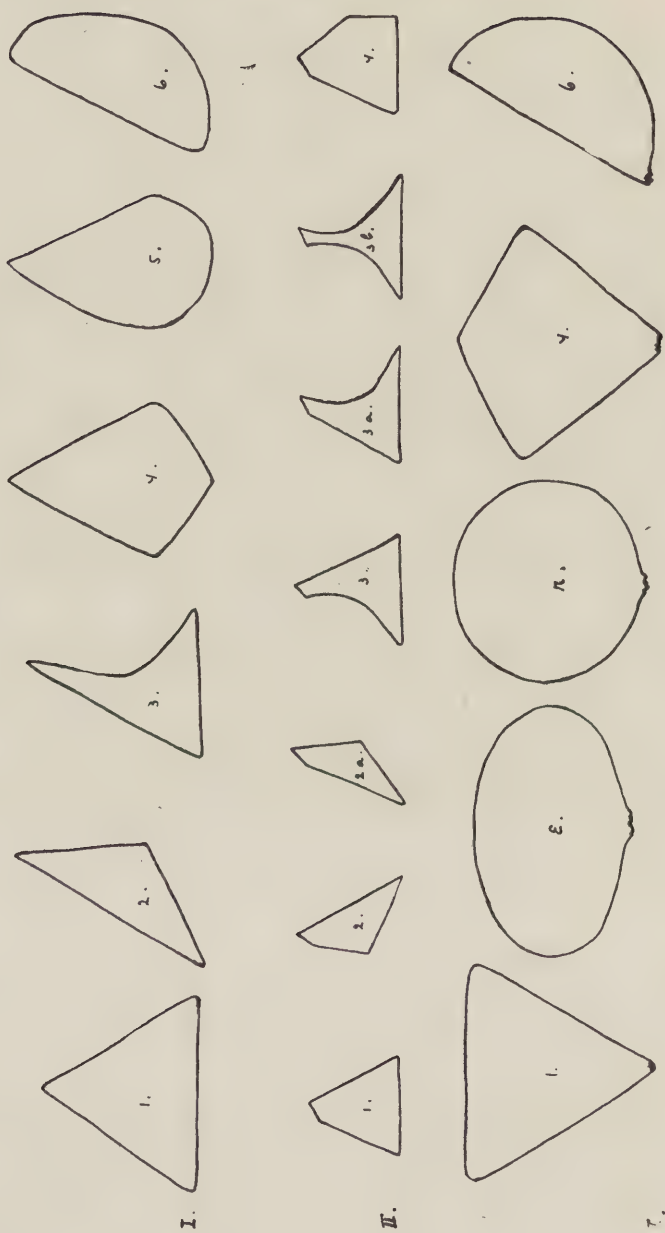
The bones of the lower extremity show more numerous and better defined differentiations of form than those of the upper extremity. Of the individual long bones, the fibula presents the greatest variety of shapes; then follow in the order named, the tibia, femur, humerus, ulna, and radius.

Perfect representations of the various types of each bone are found whenever large collections are examined, but the less perfect and less clearly distinguishable types are always more common. Besides there is always a considerable percentage of bones which present intermediary or indefinite, and a small proportion which show combined forms.

The form of shaft common to all the long bones in man is the prismatic (No. 1). The outline of the cross-section of a shaft of this type approaches the equilateral triangle. This type is also common in apes, and more or less modified in lower mammals. The base of the prism is formed in the tibia, fibula, and humerus by the posterior surface; in the femur by the anterior surface; in the ulna by the internal, and in the radius by the external surface of the bone. In whites this type of shaft is most frequent in the humerus and tibia. In the fibula it is more or less modified by the narrow anterior surface of the bone.

The nearest modifications of type 1 are types of shaft Nos. 2 and 4. Type 2 occurs principally in the tibia, fibula and humerus; and is characterized by the obliquity of the posterior surface of the bone. The outline of the cross-section is a lateral triangle, a half lozenge (more or less). Type 4 occurs in all the long bones, and is charac-

chez l'homme et chez les singes. *Bull. Soc. d'Anthrop.* Paris, 1887, Sér. 3, X, 128.—Mémoire sur la platycnémie chez l'homme et chez les anthropoïdes. *Mém. & Bull. Soc. d'Anthrop.* Paris, 1888, Sér. 2, III, 469.—Étude sur les variations morphologiques du corps de fémur dans l'espèce humaine. *Bull. Soc. d'Anthrop.* Paris, Sér. 4, IV, III; *Rev. d'École d'Anthrop.* Paris, 1893, III, 389. And Graves (Wm. W.)—The scaphoid scapula. *Med. Record*, May 21, 1910; *Wien. klin. Woch.*, 1912, XXV, No. 6; *J. Cutan. Dis.*, etc., April, 1913; and others on same subject.



terized by the presence of a distinct additional surface on the shaft. The formation of the surface differs in the various bones. In the tibia the additional surface results from a division into two, by a vertical ridge, of the posterior surface; in the femur it is the anterior, in the radius the external, and in the ulna the posterior surface, which occasionally, through the influence of a vertical ridge, shows a formation of a distinct additional plane; in the humerus, finally, a new, anterior surface results occasionally by the broadening out of the anterior border of the bone. The cross section of the shaft in these cases differs from lozenge shape (more or less) to a more even quadrangle.

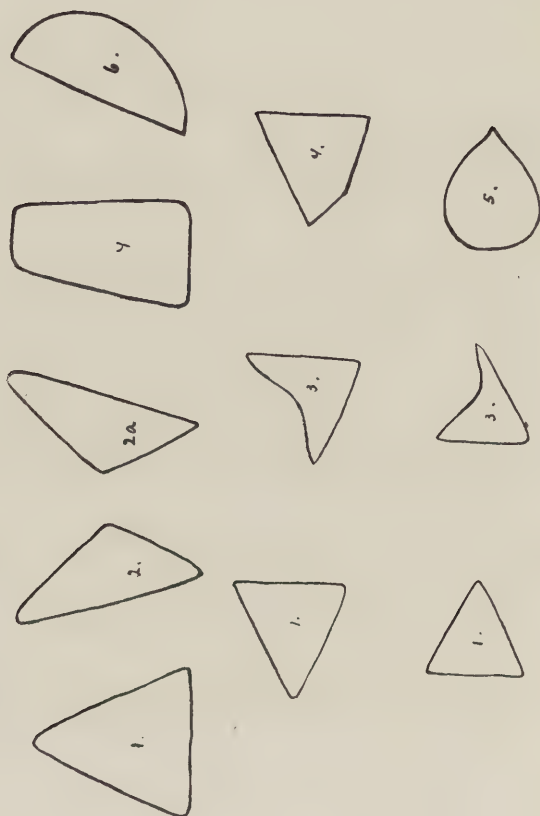
A special class of modifications of the form of the shaft is that where one or more surfaces of the bone show a pronounced concavity. We find such types (3, 3a, 3b,) particularly in the fibula, but also in the tibia, ulna and radius. In the fibula the concavity affects especially the external, but also the internal, and occasionally both the external and internal, and even the posterior surfaces; in tibia the character is observed on the external, and in the ulna and radius mainly on the anterior, flexor, surface.

Types 5, 6, *e* and *r*, are widely differing forms of the shaft of some of the long bones; all these types have, nevertheless, two features in common, and that is an indistinctness or complete absence of one or more of the borders of the bone, with marked convexity of two or all the surfaces.

Type 5 occurs occasionally in the tibia and frequently in the radius. It is marked by the convexity of the posterior tibial and external radial surface, and by indistinctness of the internal and sometimes also the external border in the tibia and the anterior and posterior borders in the radius. In both bones, but particularly in the tibia, this type of form represents a deficiency in the differentiation of the bone.

Type No. 6 occurs in the tibia, femur and humerus. The shaft is plano-convex. Types *e* (elliptical) and *r* (round, cylindrical) are found in the femur.

The condition of flatness in long bones occurs quite independently of the shape otherwise of these shafts. Flatness is not only found in the tibia, but also in the fibula (lateral), in the femur (antero-posterior of whole shaft, and, independently, antero-posterior of the upper part of the shaft, below the minor trochanter), and in the humerus (lateral). The flat femur (whole shaft) occurs almost exclusively in whites and independently of the flatness of other long bones. It is a



IV.

V.

VI.

rare and possibly abnormal condition. A flat tibia is often accompanied by a flat fibula, and not seldom also by a platymeric (flat in upper part) femur.

The *scapula* presents three main shapes or types, namely, the triangular or wedge-shaped; the bi-concave, with its axillary and especially vertebral border concave (the "scaphoid" scapula of Graves); and the convex, with its vertebral border markedly convex.

Causes.—The shape of the bones is influenced by heredity, stage of development, sex, muscular activity, size of body, and pathological conditions.

Heredity: There are reasons to believe that certain types of bones run in families; and essentially through differences in heredity there are marked differences in the relative frequency of occurrence of the various types in different races.

Stage of life: During fetal life and early childhood, the shapes of bones are fewer in number, and do not always correspond to the shapes the bones will eventually have in the adult. Differentiation advances with age and the shape of a bone is probably not fully stabilized, particularly as to fluting, before advanced adult life.

Sex: The male bones show on the whole a greater differentiation of shapes than the females; also, some types of form are more common in one sex than in the other. Most, if not all these differences, may, however, be due to differences in muscular activities.

Race: The modern cultured Whites show more variation in shape of bones than the Indians, and the Indians more than the Negro or Negrito. The causes appear to be partly hereditary and partly occupational.

Muscular activity: Muscular peculiarities and muscular activities of the individual exercise a potent influence in modifying the shape of the bones.

Size of the body: The largest and the smallest bones of any variety show in general less differentiation than the average; and weak bones show more uniformity than the strongly developed.

Pathological: Very prolonged undernourishment or vitiated state of blood during fetal life or childhood may undoubtedly affect the general development as well as the shape differentiation of bones; but no proof exists that special pathological states are responsible for any special form-types of individual bones.

The sum of the observations points to the fact that the principal causes of the various shapes of the shafts of the long and bodies of

other bones must be sought for, first, in original differences in the attachment of the various muscles on the shafts; and second, in an unequal development and work of the individual muscles during childhood and adolescence. The original differences in attachment, some of which can be clearly seen on the bones, are in all probability partly hereditary, partly early acquired conditions. The manner in which the differently attached or differently developed muscles affect the shape of bone must of course be largely if not entirely mechanical.

ADDITIONAL OBSERVATIONS

In addition to shape, the bones of the skeleton offer an array of highly interesting points for observation, and many of these, as already mentioned, are of phylogenetic importance. Of these, the main ones will be included in the blanks to be given.

MEASUREMENTS

Blank:

HUMERUS

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Length Max.	At Middle :			Observations :				
				Diam. Major (a)	Diam. Minor (b)	Index $\left(\frac{b \times 100}{a}\right)$	Shape of Shaft ¹	Perforation of Septum ²	Supra-condylar Processes ³	Special	Pathological

¹ Type 1 = prismatic; 2, 2a = lateral prismatic (2 = posterior surface facing backward and inward; 2a = posterior surface facing backward and outward); 4 = quadrilateral (anterior border broadened out to a distinct fourth surface); 6 = plano-convex; i = intermediary or indistinct.

² pp = pin point; sm = small; m = medium; l = large. When double or multiple, state so.

³ None (—); rough trace = r. t.; ridge: slight, medium, pronounced (r. sl-m-pr); tubercle: slight, or medium (tb. sl-m); process: 1/3, 1/2, 2/3, etc., complete (pr. 1/3, 1/2, 2/3, etc.).

Notes.—The *length* is taken on the osteometric board. Apply head to the vertical, take hold of bone by left hand, apply block to distal extremity, and raising bone slightly, move up and down as well as from side to side until maximum length is determined.

Diameter major at middle.—*C. g.* Determine mid-point of shaft on osteometric board and mark with pencil.

Diameter minor at middle.—Apply fixed branch of sliding compass to the antero-lateral surface at middle and take measurement.

RADIUS

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Length Max.	Shape ¹	Anomalies	Pathological	Radio—Humeral Index ²	

Note: Maximum length is taken in same way as that of the humerus.

ULNA

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Length Max.	Shape ³	Anomalies	Pathological	

Note: Maximum length is taken in same way as that of the humerus.

¹ 1 = prismatic; 2 = flexor surface concave (fluted); 5 = external surface convex, borders indistinct.

² $\frac{\text{Length of Radius} \times 100}{\text{Length of Humerus}}$

³ 1 = prismatic, 2 = flexor surface concave (fluted); 4 = quadrilateral (posterior) surface divided into two, so that the shaft presents four distinct surfaces, borders and angles.

FEMUR

Tribe..... Locality..... Observer.....

Right

Cat. No.	Sex	Age	Length Bicondylar	Length Max.	Humero- femoral Index ¹	At Middle:		
						Diam. Antero- Posterior Maxim.	Diam. Lateral	Index ²

(Continued)

Left

At Upper Flattening:			Observations:					
Diam. Lateral Maxim.	Diam. Antero- posterior Minim.	Index ³	Shape of Shaft ⁴	Third Condyle ⁵	Linea Aspera ⁶	Anomalies	Patho- logical	

Notes: The *bicondylar length* of the femur is taken by adjusting both condyles to the vertical part of the osteometric board and applying the block to the other extremity.

The *length maximum* of the femur is measured in the same way as the maximum length of other bones (see under Humerus).

The *antero-posterior diameter at middle* (middle of shaft determined and marked beforehand) is the diameter maximum.

The *lateral diameter at middle* is taken so that the linea-aspera reposes on the stem of the sliding compass midway between the two branches of the same while these are applied to the bone.

$$^1 \frac{\text{Length of Humerus} \times 100}{\text{Bicondylar length of femur}}$$

$$^2 \frac{\text{Diam. lat.} \times 100.}{\text{Diam. ant.-post.}}$$

$$^3 \frac{\text{Diam. minim} \times 100.}{\text{Diam. maxim.}}$$

⁴ Type 1 = prismatic; 4 = quadrilateral (anterior surface divided by a vertical ridge in two); r = cylindrical (juvenile); e = elliptical; pc = plano-convex.

⁵ r = ridge; o. t. = oblong tuberosity; r. t. = round tuberosity; d = depression; All: slight, moderate, or pronounced.

⁶ sl., mod., pron.

In plano-convex and related femora the shaft is so deformed and the linea-aspera so displaced, that the measurement of the diameters is impractical and should be omitted.

Circumference of the shaft at middle as taken by some observers and contrasted with the length of the bone gives data of some value for sexual identification; but the same may be done with the mean of the two diameters.

TIBIA

Tribe..... Locality..... Observer.....

Right

Cat. No.	Sex	Age	Length (Less Spine) (T)	Length Maxim.	Tibio-femoral Index ¹	At Middle:		
						Diam. Antero-posterior Max. (a)	Diam. Lateral (b)	Index ($\frac{b \times 100}{a}$)

(Continued)

Left

Observations:		Pathological:			
Shape ²		Peculiarities	Curvature	Exostoses	Other

Notes: To take the ordinary length of the tibia introduce the spine into the orifice provided for this purpose in the vertical part of the osteometric board, apply outer parts of the condyles to the vertical outside of the orifice, let body of the bone repose on the horizontal part of the board, and apply block to the most distant point (malleolus).

¹ $\frac{T \times 100}{\text{Bicond. l. of femur}}$

² Type 1 = prismatic; 2 = lateral prismatic; 3 = external surface concave (fluted); 4 = posterior surface divided in two; 5 = posterior surface convex, internal border indistinct; 6 = plano-convex (gorilloid).

It is also useful to take the maximum length of the tibia. This is secured by placing the spine within the orifice as with the previous measurement, applying the most prominent point of the condyles to the vertical, taking hold of the body by the left hand and moving the bone from side to side as well as slightly upward and downward, while holding the block applied to the malleolus, until the maximum length is determined.

FIBULA

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Length Max.	Shape ¹	Anomalies	Pathological	

SCAPULA

Tribe..... Locality..... Observer.....

Right

Cat. No.	Sex	Age	Height Total (a)	Height Infra-scapular (b)	Breadth (c)	Index: ² Total	Index: Inferior ³	Type ⁴

Notes: The total height of the scapula is obtained by measuring in a straight line the distance from the superior to the inferior angle.

¹ 1 = Ordinary quadrilateral, approaching prismatic; anterior surface nearly absent to moderate; posterior surface facing directly backward or nearly so. 2 = Lateral prismatic; posterior surface facing backward and inward; medial surface much less in area than lateral; anterior surface narrow to broad. 2a = relation between medial and lateral surface reversed, the latter being the narrower. 3 = medial surface fluted; 4 = lateral surface differentiated into two surfaces; 5 = lateral surface fluted; 6 = both medial and lateral surfaces fluted; 9 = all three surfaces deeply fluted.

$$\frac{^2 c \times 100}{a}$$

$$\frac{^3 c \times 100}{b}$$

⁴ Type: 1 = triangular; 3 = biconcave ("scaphoid"), axillary and vertebral borders concave; 6 = convex, vertebral border convex.

SCAPULA

(Continued)

Left

Observations:					
Shape of Superior Border ¹	Notch ²	Vertebral Border ³	Axillary Border ⁴	Anomalies	Pathological

The *infra-spinous height* is the height from the inferior angle to a point at which the spine transects the vertebral border of the bone. To determine this point hold scapula in left hand with dorsal surface up in such a way that the eye can follow the prolongation of the spine to the axillary border. Mark the mid point of the juncture of the spine with the border (and not the lower or upper limit).

The breadth of the scapula (*c*) is the diameter from the middle of the outer (dorsal) border of the glenoid cavity to the point where the spine intersects the vertebral border. (Broca, P. —Sur les indices de longueur de l'omoplate chez l'homme, les singes et dans la série des mammifères. *Bull. Soc. d'Anthrop.*, 1878, Sér. 3, I, 66.)⁵

STERNUM⁶

Tribe..... Locality..... Observer.....

Cat. No	Sex	Age	Total Length (Less Xiphoid) (s)	Length of Manubrium (m)	Manubrial Index ($\frac{m \times 100}{s}$)	Greatest Breadth of Body (b)	Sternal Index ($\frac{b \times 100}{s}$)	Maximum Thickness of Body	Number of Rib Facets		Anomalies	Remarks
									r.	l.		

¹ 1 = horizontal, at right angle, or near, with coracoid; 2 = moderate obliquity upwards, angle 55-80; 3 = pronounced obliquity, angle near 45; 4 = semiquadrate; 5 = semicircular; 6 = wavy.

² 1 = none; 2 = slight; 3 = moderate; 4 = nearly a foramen; 5 = foramen.

³ 1 = straight; 2 = concave; 3 = convex: slightly—moderately—pronouncedly.

⁴ 1 = straight; 2 = teres process slight; 3 = moderate; 4 = pronounced.

⁵ Were it not for the amount of work done with this breadth, it would be preferable to take that from the slight depression or roughness in the middle of the glenoid fossa to the spine-point, for the borders of the fossa are liable to some irregularities of development, besides which the mid-glenoid point is the more suitable in measurements of scapulae of various animals.

⁶ Consult: Anthony (R.)—Notes sur la morphogenie du Sternum chez mammiferes.

Notes: The length of the sternum as well as that of the manubrium is best measured on the osteometric board; the breadth and thickness of the bone are measured with the sliding compass. The thickness of the body should be measured between the facets for the ribs.

Among the anomalies are to be observed especially the foramen or defect in the lower part of the bone, and the occurrence of episternals.

The relative proportions of the manubrium and body of the sternum show sexual as well as group differences; and the same may be said in regard to the fusion of the manubrium with the body of the bone.

CLAVICLES¹

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Length Maximum	Conoid Tuberosity	Strength ²	Curvature ³	Anomalies	

Notes: The length of the clavicle is best determined on the osteometric board, but may also be measured by the small or the large sliding compass.

The comparison of the length of the clavicle with the length of the humerus (*claviculo-humeral index*) is useful as an indication of the relative development of the thorax.

The acromial extremity may in rare cases be separated; a few other anomalies may also occur.

Bull. Soc. d'Anthrop. Paris, 1901, II, 19-43. Dwight (Thos.)—The Sternum as an index of sex, height and age. *J. Anat. & Physiol.*, 1890, XXIV, 527-535. Krause (W.)—Ueber das weibliche Sternum. *Intern. Monatsschr. f. Anat. & Physiol.*, 1897, XIV, 21-32. Parker (W. J.)—Structure and development of the Shoulder Girdle and Sternum in the Vertebrates. *Roy. Soc. Publ.*, Lond., 1868. Paterson (A. M.)—The human sternum. Liverpool, 1904; also *Brit. Med. J.*, 1902, II; and *J. Anat. & Physiol.*, 1900, XXXV, Pt. 1.

¹ Consult Pasteau (E.)—Recherches sur les proportions de la Clavicule. *Thèse méd.*, Paris, 1879; also Parsons (F. G.)—On the proportions and characteristics of the modern English Clavicle. *J. Anat., Lond.*, 1916, LI, 71-93.

² *Sl* = slender; *m* = medium; *str* = strong; *mas* = massive.

³ *Sl* = slight; *m* = medium; *pron* = pronounced.

RIBS¹

Tribe..... Locality..... Observer.....

Cat. No.	Sex	Age	Number Present		Anomalies	Fractures and Pathological	1st Rib Shape. ²	Remarks
			R.	L.				

Notes: In skeletal material obtained from older graves the ribs are seldom all present and in good condition; nevertheless their examination should not be neglected. Cervical, supernumerary, bifid, bicipital and fused ribs are of special interest; and other anomalies may occur.

The first rib deserves special attention, particularly as to its shape. The development of the scalene tubercle may also be noted on the first rib.

SPINE³

Tribe..... Locality..... Observer.....

Cat. No.	Sex.	Age	Atlas:		Other Cervical:			Dorsal:			Lumbar:			Remarks
			Anomalies	Re-marks	Number	Anomalies	Re-marks	Number	Anomalies	Re-marks	Number	Anomalies	Re-marks	

¹ Bardeen (Ch. R.)—Costo-vertebral variation in Man. *Anat. Anz.*, 1900, XVIII, 377-382. Hrdlička (Aleš)—Contribution to the Osteology of Ribs, *Proc. Ass. Am. Anat.*, XIV Sess., Wash., 1901, 61-68. Tredgold (A. F.)—Variations of Ribs in the Primates with especial reference to the number of sternal Ribs in Man. *J. Anat. & Physiol.*, 1897, XXXI, 288-302.

² 1 = curved (semilunar); 2 = monoangular or pistol-shaped (nearly straight neck, with nearly straight body); 3 = biangular (distinct angle in body, besides that between neck and body).

³ Consult: Anderson (R. J.)—Observations on the diameters of human vertebrae in different regions. *J. Anat. & Physiol.*, London, 1883, XVII, 341-4. Bardeen (Chas. R.)—Numerical Vertebral Variation in the Human Adult and Embryo; *Anat. Anz.*, 1904, XXV, 497-519. Cunningham (D. J.)—Lumbar Curve in Man and the Apes. Dublin, 1886. Dubreuil-Chambardel (L.)—Variations sexuelles de l'Atlas. *Bull. & Mém. d'Anthrop.*, Paris, 1907, VIII, 399-404. Dwight (Thomas)—

Notes: Various measurements and many detailed observations are possible on the spine and its different constituents. As to measurements, the most interesting are the relative lengths of the cervical, dorsal and lumbar parts of the spine compared with the total length of the three. The length of these parts is best taken by the small and large sliding compasses, between the mid points anteriorly of the upper and lower border of the body of the first and last vertebra of each segment, with the bones held in a close and natural apposition.

The atlas should receive special attention, for it is subject to many independent variations, particularly in respect to blood vessel foramina and canals.

The lowest part of the dorsal and the uppermost as well as lowermost parts of the lumbar segment, are also of special interest, the former on account of occasional numerical variation, the latter on account of occasional separation of neural arch, a presence of a sacral element with more or less assimilation, etc.

The minor anomalies of the spine and its constituents should be reserved for special study.

SACRUM, PELVIC BONES, PELVIS

Tribe..... Locality..... Observer.....

Cat. No.	Sex	Age	Sacrum:						Special
			Height Maxim. ¹	Breadth Maxim.	Sacral Index ²	Number of Segments	Curva- ture ³	Curvature Begins at ⁴	

Description of the Human Spines showing numerical variation. Mem. Boston Soc. Nat. Hist., 1901, 237-312, also, *Anat. Anz.*, 1901, XIX, 332, 337-347; and *Anat. Anz.*, 1906, XXVIII, 33-40, 96-102. Hrdlička (Aleš)—The atlas of Monte Hermoso. In *Bull. 52, Bur. Am. Ethnol.*, Wash. 1912, 364-9. Papillault (G.)—Variations numériques des vertèbres lombaires chez l'homme. *Bull. Soc. d'Anthrop.*, Paris, 1898, IX, 198-222. Ranke (J.)—Zur Anthropologie der Halswirbelsäule. Sitz. math. phys. Cl. bayer. Akad. Wiss., 1895, XXV, 1-23. Ravenel (M.)—Die Maasverhältnisse der Wirbelsäule und des Rückenmarkes beim Menschen. *Dwang. Dissert.*, Leipzig, 1877, 1-27. Regalia (C. E.)—Sulla causa generale delle anomalie numeriche del rachide. *Arch. p. Antrop. & Etn.*, 1895, XXV, 149-219. Rosenberg (E.)—Ueber die Entwicklung der Wirbelsäule. *Gegenbaur's Morphol. Jahrb.*, Leipzig, 1875, I, 1-111. Soularue (G. Martial)—Étude des proportions de la colonne vertébrale chez l'homme et chez la femme. *Bull. Soc. d'Anthrop.* Paris, 1900, Sér. 5, I, 132-147. Zoja (G.)—Sulle varietà dell'atlante. *Bol. sci.*, 1881, Nos. 1 & 2, repr. 24 pp., Also C. R. R. Ist. Lomb., Cl. Sc. mat. & nat., 1881, XIV, 269-296.

SACRUM, PELVIC BONES, PELVIS

(Continued)

Ossa Innominata:						Pelvis:					
Height Maxim.		Breadth Maxim.		Mean Index ⁵	Special Features	Breadth Maxim. ⁶	Total Index ⁷	Superior Stralt: Breadth Maxim.	Diameter Antero-posterior Maxim. ⁸	Pelvic Index	Re- marks
Right	Left	Right	Left								

Notes: In measuring the height of the sacrum use sliding compass, and apply points of instrument to middle of promontory and middle of anterior-inferior border of the fifth sacral vertebra. For general comparative purposes measure only sacra with five segments.

In measuring breadth apply stem of compass to the upper surface of the body of the first sacral vertebra and measure the greatest expanse of the lateral masses of the bone.

The height of the ossa innominata is best measured on the osteometric board. Apply ischium to the vertical part of the board, hold bone with left hand, apply block to iliac border with right hand and move bone up and down and from side to side until maximum measurement is obtained.

The breadth of the ossa innominata is best measured by the sliding compass. It is the distance between the anterior and posterior superior spines.

For measuring the pelvis as a whole articulate the bones, hold with both hands, invert, and secure breadth maximum of ilia on the osteo-

¹ Long branch of sliding compass applied ventrally, in median line, to anterior border of lower end and to promontory.

² $\frac{\text{Breadth} \times 100}{\text{Height}}$

³ Slight, moderate, pronounced.

⁴ Name segment (from above).

⁵ $\frac{\text{Mean breadth} \times 100}{\text{mean height}}$

⁶ Pelvis held together with bones in natural position; the bread this the bi-iliac maximum, and can be taken handily on the osteometric board, or by a second person with the large sliding compass.

⁷ $\frac{\text{Breadth} \times 100}{\text{mean height of ossa innominata}}$

⁸ From promontory of the sacrum to the nearest point on the ventral border of the pubic bones.

metric board. With the help of a pelviphore (such as that of Emmons) the taking of this measurement and of those of the brim becomes a simple matter.

To measure the diameters of the superior strait or brim of the pelvis without a pelviphore, hold pelvis in left hand, and use small sliding compass. The antero-posterior diameter is that between the mid point on the promontory of the sacrum and the nearest point on the ventral borders of the pubic articulation. The lateral diameter is the maximum transverse diameter of the brim.

A natural slight separation of the pubic bones should be retained during all measurements.

SHORT BONES

Patella.¹

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Height Maxim.	Breadth Maxim.	Thickness Maxim.	Breadth-Height Index $\frac{(B \times 100)}{H}$	Patellar Module $\frac{(H + B + T)}{3}$	Vastus Notch ²

Notes: All the measurements to be taken with the small sliding compass. In measuring the height and breadth of the bone, move the latter slightly from side to side between the branches of the compass until the maximum measurement is determined. The height is taken by applying the fixed branch to the anterior surface of the bone and bringing the movable branch posteriorly over its thickest parts.

The vastus notch shows interesting variations.

¹ Consult: Corner (E. M.)—Varieties and structure of the Patella of Man. *J. Anat. & Physiol.*, 1900, XXXIV, XXVII-XXVIII; also Ten Kate (H.)—Rotule. *Rev. Mus. La Plata*, 1896, VII, 12-16; and *Bull. 62, Bur. Amer. Ethnol.*, Wash. 1916.

² — none; *sl* = slight; *m* = moderate; *l* = large.

CALCANEUS¹

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Length Maxim.	Breadth Minim.	Height of Body	Breadth- Length Index ($B \times 100$) <i>L</i>	Breadth- Height Index ($B \times 100$) <i>H</i>	Height- Length Index ($H \times 100$) <i>L</i>	Module ($L + B + H$) 3	Articular Facets for Astragalus	Anomalies	Remarks

Notes: All measurements to be taken with the small sliding compass. The taking of the maximum length will be self-evident. To secure the breadth, the branches of the compass should be applied to the sides of the bone in the region of the minimum thickness of its body. The most practicable height of the calcaneus is obtained by moving the bone from side to side between the branches of the compass, which are applied to what is seen to be the greatest constriction of the body (approximately its middle).

As to visual observations on the Os calcis, the greatest interest attaches probably to the number and conformation of the articular facets for the astragalus. These facets may be two in number, anterior and posterior. But the anterior facet may be divided into two by a ridge; or it may be replaced by two facets, anterior and median, completely separated by a narrow to moderately broad groove or space; or, finally, in place of the single oblong anterior facet there may be a small to rudimentary anterior and a medium-sized median facet, separated by a broad and deep notch.

An additional point of some interest is the development of the peroneal spine.

¹ See *Bull. 62, Bur. Amer. Ethnol.*, Wash., 1916.

ASTRAGALUS¹

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Length Maxim.	Breadth Maxim.	Height Maxim.	Breadth- Length Index $\frac{(B \times 100)}{L}$	Height- Length Index $\frac{(H \times 100)}{L}$	Module $\frac{(L+B+H)}{3}$	Facets for Calcaneus ²	Special

Notes: For length maximum, apply stem of sliding compass to lowest (most prominent) parts of the medial surface on the bone.

The maximum breadth is taken by applying the fixed branch of the sliding compass to the lowest (most prominent) parts on the medial surface of the bone.

The maximum height of the astragalus is best taken on the osteometric plane, on which the bone is placed so that all the three lowest points of its inferior surface touch the vertical part, while the block is applied to the most prominent part of the bone from the opposite direction.

A comparative study of the calcaneus facets on the talus with the corresponding facets on the latter bone, is of considerable interest, and shows some racial variations.

SCAPHOID³

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Breadth Maxim.	Height Maxim.	Stoutness Maxim.	Height- Breadth Index $\frac{(H \times 100)}{B}$	Stoutness- Breadth Index $\frac{(S \times 100)}{B}$	Facet for Cuboid ⁴	Facet for Talus, Form ⁵	Tuber- osity ⁶	Addi- tional

¹ See *Bull. 62, Bur. Am. Ethnol.*, Wash., 1916.

² 1 = one facet not divided by any ridge; 2 = one facet divided into two by a ridge; 3 = two distinct facets, but slightly connected or completely apart.

³ See *Bull. 62, Bur. Am. Ethnol.*, Wash., 1916.

⁴ Present or absent.

⁵ *pf* = pyriform; *q* = quadrilateral; *i* = intermediary or indefinite.

⁶ *p* = pointed; *bl* = blunt (markedly); *sq* = squarish.

Notes: The maximum breadth of the bone is taken by the small sliding compass and is measured from the extremity of the tuberosity ad maximum.

To take the maximum height of the bone use the large sliding compass with broad branches; hold instrument vertically, lay bone on movable branch on its talus facet, raise the branch until the bone touches the under surface of the fixed branch and read measurement.

To measure the stoutness use same instrument as for height. Lay bone on the movable branch of the compass on its dorsal or superior surface, let it assume a natural position, and raise the branch until the most prominent part of the plantar surface of the bone touches the under surface of the fixed branch.

CUBOID¹

Tribe..... Locality..... Observer.....

Right						Left					
Cat. No.	Sex	Age	Length Maxim.	Breadth Maxim.	Thickness Maxim.	Breadth- Length Index $\frac{(B \times 100)}{L}$	Thickness- Length Index $\frac{(T \times 100)}{L}$	Module $\frac{(L+B+T)}{3}$	Facet for Cuneiform ²	Facet for Talus ³	Additional

Notes: The maximum length of the bone is measured with the small sliding compass, between the most prominent point on the superior and inferior borders of the distal or metatarsal facet of the bone and the point at the inferior medial angle (calcanean process).

The maximum breadth is obtained with the cuboid resting on its medial surface in such a position as it naturally assumes. This and the next measurement are best taken by the large sliding compass with broad branches.

The maximum thickness is taken with the cuboid resting on its anterior surface in such position as it naturally assumes.

¹ See *Bull. 62, Bur. Am. Ethnol.*, Wash., 1916.

² s = single; r = divided in two by a well marked ridge; 3 = double (connected or not).

³ Present or absent.

INTERNAL CUNEIFORM¹

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Height Maxim.	Breadth Minim.	Breadth-Height Index ($B \times 100$) H	Metatarsal Facet ²	Additional	

Note: Measurements taken with sliding compass. Height maximum is secured by applying the fixed branch of the compass to the most prominent parts of the inferior surface of the bone and bringing the other branch into apposition.

The minimum breadth, in the middle of the bone, is obtained by applying the fixed branch of the compass so that it rests on both lips of the scaphoid facet, and bringing the other branch into apposition with the bone. It is the only practicable breadth in all specimens.

External cuneiform: Note frequency of absence of facet for fourth metatarsal, also for second metatarsal.

Middle Cuneiform: Note character of central ligamentous depression and canal running downward from this.

BONES OF THE HAND³

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Bones of Carpus:		Metacarpals:			Metacarpophumeral Index ⁴	Phalanges:	
			Number	Observations	Number	Remarks	Length Max. of 1st Metacarpal		Number	Remarks

¹ See *Bull. 62, Bur. Am. Ethnol.*, Wash., 1916.

² Single or double.

³ See *Bull. 62, Bur. Am. Ethnol.*, Wash., 1916.

⁴ $\frac{\text{Max. length of 1st metacarpel} \times 100}{\text{Max. length of humerus}}$

Max. length of humerus

BONES OF THE FOOT¹

Tribe..... Locality..... Observer.....

Right

Left

Cat. No.	Sex	Age	Metatarsals:				Re- marks	Phalanges:			
			Number	Observations	1st Metatarsal:			Num- ber	Re- marks		
					Length Maxim.	Pollux-Hal- lux Index ²					Hallux Fe- mur Index ³

ESTIMATION OF STATURE FROM PARTS OF THE SKELETON⁴

The International Agreement of Geneva stipulates that: "For the reconstruction of the stature with the aid of the long bones, the maximum length shall be measured in all cases save in those of the femur which is to be measured in the oblique position, and the tibia which is also to be measured in the oblique position, the spine being excluded."

Under these conditions and until something more serviceable may be provided, the student is advised to use Manouvrier's tables, which are here reproduced. These tables apply only to bones of adults; and a proper sexual identification is in each case of the greatest importance. All the long bones present should be measured and the mean length of each pair used for the approximations in the table, the mean of the total of approximations giving the stature.

¹ See *Bull. 62, Bur. Am. Ethnol.*, Wash. 1916.

² $\frac{\text{Max. length of 1st metacarpal} \times 100}{\text{Max. length of 1st metatarsal}}$

³ $\frac{\text{Max. length of 1st metatarsal} \times 100}{\text{Bicondylar length of femur}}$

⁴ Dwight (Thos.)—Methods of estimating the height from parts of the skeleton. *Med. Rec.*, Sept. 8, 1894. (Gives data for estimating stature also from length of sternum and that of the spine.) Manouvrier (L.)—Détermination de la taille d'après les os longs. *Rév. Éc. d'Anthrop.* Paris, 1892, II, 227.—La détermination de la taille d'après les grands os des membres. *Mem. Soc. d'Anthrop.*, Paris, 1893, Sér. 2, IV, 347-411. Pearson (K.)—On the reconstruction of the stature of prehistoric races. *Philos. Trans. R. Soc.*, London, 1899 (Mathematical); CXCH, Ser. A, 169-244. Rollet (E.)—La mensuration des os longs des membres. *Thèse méd.*, Lyon, 1899 (Similar to Manouvrier). Topinard (P.)—De la restitution de la taille par les os longs. *Rev. d'Anthrop.*, Paris, 1885, VIII, 134.—Procédé des mensuration des os longs dans le but de reconstituer la taille. *Bull. Soc. d'Anthrop.*, Paris, 1885, VIII, 73-83. Also *Éléments d'Anthropologie générale* (used maximum lengths throughout). Older data unreliable and lack precision of methods.

The final estimate will be the more reliable the larger the series of subjects involved. In single individuals the error, as Dwight has shown, may be very considerable, particularly in tall males (1 up to 11.9 cm.).¹

Percentage of Stature								
	17.7	18.1 to 18.5	18.6 to 19	19.1 to 19.5	19.6 to 20	20.1 to 20.5	20.6 to 21	21.1 to 21.6
	Percent of Bones							
Males.....	1.4	11.7	24.3	27.1	21.6	9	3.7	1.1
Females.....	...	12.2	20.7	31.7	18.3	9.8	7.3	...

MANOUVRIER'S TABLES SHOWING THE CORRESPONDENCE OF BONE LENGTHS AMONG THEMSELVES AND WITH STATURE

Males						
Humerus	Radius	Ulna	Stature	Femur	Tibia	Fibula
cm.	cm.	cm.	cm.	cm.	cm.	cm.
295	213	227	1,530	392	319	318
298	216	231	1,552	398	324	323
302	219	235	1,571	404	330	328
306	222	239	1,590	410	335	333
309	225	243	1,605	416	340	338
313	229	246	1,625	422	346	344
316	232	249	1,634	428	351	349
320	236	253	1,644	434	357	353
324	239	257	1,654	440	362	358
328	243	260	1,666	446	368	363
332	246	263	1,677	453	373	368
336	249	266	1,686	460	378	373
340	252	270	1,697	467	383	378
344	255	273	1,716	475	389	383
348	258	276	1,730	482	394	388
352	261	280	1,754	490	400	393
356	264	283	1,767	497	405	398
360	267	287	1,785	504	410	403
364	270	290	1,812	512	415	408
368	273	293	1,830	519	420	413
Mean Coefficients for bones shorter than those shown in the Table:						
5.25	7.11	6.66	.....	3.92	4.80	4.82
Mean Coefficients for bones longer than those shown in the Table:						
4.93	6.70	6.26	.....	3.53	4.32	4.37

To determine from this table the stature of the living, add 2 mm. to each length; take the mean of the resulting statures, and subtract 2 mm. from the final height thus obtained.²

¹ The author obtained the following correspondences between the humerus and stature in 354 male and 82 female dissecting room individuals, Whites, 22-25 years of age, and where both humeri could be measured.

² Dwight found that a large proportion of the errors with the Manouvrier tables was due to this subtraction, and advocates that this recommendation be not followed. It should be stated by the author whether it was or was not followed.

MANOUVRIER'S TABLES SHOWING THE CORRESPONDENCE OF BONE LENGTHS AMONG
THEMSELVES AND WITH STATURE—*Continued*

Females						
Humerus	Radius	Ulna	Stature	Femur	Tibia	Fibula
cm.	cm.	cm.	cm.	cm.	cm.	cm.
263	193	203	1,400	363	284	283
266	195	206	1,420	368	289	288
270	197	209	1,440	373	294	293
273	199	212	1,455	378	299	298
276	201	215	1,470	383	304	303
279	203	217	1,488	388	309	307
282	205	219	1,497	393	314	311
285	207	222	1,513	398	319	316
289	209	225	1,528	403	324	320
292	211	228	1,543	408	329	325
297	214	231	1,556	415	334	330
302	218	235	1,568	422	340	336
307	222	239	1,582	429	346	341
313	226	243	1,595	436	352	346
318	230	247	1,612	443	358	351
324	234	251	1,630	450	364	356
329	238	254	1,650	457	370	361
334	242	258	1,670	464	376	366
339	246	261	1,692	471	382	371
344	250	264	1,715	478	388	376
Mean Coefficients for bones shorter than those shown in the Table:						
5.41	7.44	7.00	.....	3.87	4.85	4.88
Mean Coefficients for bones longer than those shown in the Table:						
4.98	7.00	6.49	.....	3.58	4.42	4.52

SPECIAL COMMUNICATIONS AND REPORTS

THE MORTALITY STATISTICS OF INSURED WAGE-EARNERS AND THEIR FAMILIES

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1. DATA ON THE RACE AND SEX RATIO OF MORTALITY AMONG WAGE-EARNERS

Students of anthropology will be interested in the above mentioned work, a recent publication on the mortality statistics of a group of more than ten million wage-earners dispersed over the United States and Canada. From these data, it will be possible to make deeper inquiries than have been possible from data hitherto available, into the influence of urban working-class environment upon mortality at the various divisional periods of life, and comparatively for the sexes; and on the relative mortality of the negro and Caucasian groups of the wage-working population. The authors have throughout the work distinguished the white and colored races, according to sex, in all of the tables, whether relating to the total mortality or to the important diseases. They have also shown comparisons of the data for white wage-earners, by sex, with those of the population of the Registration Area in the United States.

It will be recalled that until this volume was issued there had been accessible no such display of detailed public health statistics relating specifically to wage-earners and to members of their families. The published statistics of mortality issued by the municipal, state and federal offices, cover the entire population and give no clue to the mortality situation among the wage-earning masses of the country. The health statistics of the negro, compiled from similar population sources, have been more or less unsatisfactory because of the lack of required detail as to sex, age and diseases causing death. Students of the health of races have long desired mortality statistics of groups comparably situated as regards urban environment and otherwise. In the present work, there is as much detail of tabulation for the white as

for the negro groups. Anthropologists may have confidence in these figures of mortality according to race, first, because they are founded upon an accurate knowledge of the number of lives exposed to risk, and second, because the processes of gathering, editing and compiling the facts of mortality were carried on with the utmost concern for accuracy.

The report covers the six years from 1911 to 1916. There were more than 635,000 deaths tabulated, of which more than four fifths (82 per cent) were those of white persons, and 18 per cent of negroes. But only 12.5 per cent. of the lives exposed to risk were negroes. The higher mortality rate of negroes becomes apparent at once from this simple comparison of the racial make-up of the exposure and of the deaths. In terms of the actual death rate, the negro group showed an excess life-loss of 56 per cent. Considered according to sex, negro males showed an excess of nearly one half (49 per cent) and negro females an excess of slightly more than three fifths (62 per cent) over the rates for the corresponding sexes among the Caucasian groups.

Anthropologists will perhaps be interested in following this ratio between the mortality figures of white and colored persons through the several age-divisions of life. From the published data this can be done not only for the total mortality, but also for any of the important diseases and conditions.

The findings on the relative mortality of whites and negroes, and of males and females, in this work may be discussed first, with respect to age, and then for the important diseases and conditions causing death.

2. EXCESS OF MORTALITY AMONG NEGROES

(a) *Males*

Considering the excess mortality among negroes over that for white persons, according to age, properly distinguishing sex, we find that whereas the negroes show for all ages one and over¹ an excess of 49 per cent among males, this ratio of excess mortality varies considerably at the several age divisions of life. Thus, in early childhood, in the period one to four years, there was an excess of 72 per cent. Between 5 and 9 years of age this excess was 49 per cent. There was a sharp increase in this ratio to a maximum of 150 per cent for colored males at 15 to 19 years of age. After age 20 this ratio tends to de-

¹ No infants under 1 are included in this insurance mortality experience.

crease until in old age there is very little difference shown in these figures between the mortality of insured male white and negro wage-earners. The data are given on page 16 of the book.

(b) *Females*

The readers of this journal will be interested in the analysis according to age, of the mortality among colored females in excess of that among white females. Between 15 and 19 years this group of negro females showed an excess of 217 per cent over the mortality of white females. After having risen to this point of maximum excess, the ratio declines gradually with age, but is higher than the excess for negro males at every age period. The reasons for the unfavorable showing of colored females, especially in the age period of early adolescence, 15 to 19 years, are not apparent from superficial examination of the figures at hand. The data suggest detailed inquiry by students of the comparative health of races. Enough material is given throughout the book for the several diseases and conditions to justify refined analysis of the figures.

3. EXCESS OF MORTALITY AMONG MALES

(a) *White Persons*

Among white persons the mortality of males, at all ages one and over, exceeded that of females by 14 per cent and among colored persons by 4 per cent. The mortality rates of the two sexes among white lives tended to approximate each other only in the ages 10 to 19 years, but at all other age periods in this present mortality experience the curves of mortality among white males and females showed a decided excess among males. The maximum excess of mortality among white males is reached in the age period 35 to 44 years, after a series of sharp increments in this ratio at the earlier ages.

(b) *Colored Persons*

The group of insured colored lives shows few of the characteristics of the sex-ratio of mortality that are found among the Caucasians. These figures emphasize the caution that inquiries into the sex-ratio of mortality by age must take into account the factor of race. Thus, between 5 and 25 years of age the death rate from all causes among colored males is very much *below* that of colored females. The age period 25 to 34 years, begins to show an excess of male mortality

(15 per cent), and this rises to a maximum figure of 19 per cent in the age group 35 to 44 years. In the ages between 45 and 75 years of age the excess of mortality among colored males varies but little from a figure of 15 per cent. It will be seen from this brief consideration of the mortality from all causes of death that no general conclusions on the comparative vitality of males and females, of white and colored persons can be drawn without considering the make-up of the mortality according to diseases and conditions.

Before passing to such a detailed discussion, however, we would direct the reader's attention to the characteristics of the two sets of curves given on pages 17 and 19 of this book. On the first mentioned page the authors have shown a chart illustrating by age the mortality from all causes of death of white males and colored males, respectively. The curve of white males is "J" shaped, or concave throughout, but that for colored males shows a convex tendency between central age 12.5 and 30 years of age. The curves on page 19 of the book show the usual "J" shaped curve of mortality for white females, but the colored female group shows a pronounced departure from the "J" conformation between central ages 12.5 and 30 years, more so than for colored males. Among the group of insured colored persons, tuberculosis seems to be responsible for most of the convex tendency of the mortality curve between central ages 12.5 and 30 years. In addition, among colored females the very high death rate from diseases and conditions connected with child-bearing and the gravid state contribute to the hump in the curve for that group at the early adult ages.

4. IMPORTANT ASPECTS OF WAGE-EARNERS MORTALITY ACCORDING TO DISEASES CAUSING DEATH

A short abstract table is given below showing the mortality from principal causes of death among this group of insured wage-earners.

DEATH RATES PER 100,000 EXPOSED. PRINCIPAL CAUSES OF DEATH AMONG WAGE-EARNERS. BY COLOR AND SEX

Cause of Death	Total	White		Colored	
		Male	Female	Male	Female
All causes of death	1,181	1,182	1,040	1,763	1,689
Tuberculosis—total	205	212	147	430	385
Tuberculosis of the lungs	186	194	132	391	349
Organic diseases of the heart	140	126	137	191	202

DEATH RATES PER 100,000 EXPOSED. PRINCIPAL CAUSES OF DEATH AMONG WAGE-EARNERS. BY COLOR AND SEX.—Continued.

Cause of Death	Total	White		Colored	
		Male	Female	Male	Female
Pneumonia—total.....	108	112	92	179	131
Bronchopneumonia.....	30	30	29	38	34
Pneumonia—lobar and undefined ..	78	83	63	142	97
Bright's disease.....	97	97	88	139	121
External causes of death ¹	94	147	45	184	58
Accidents.....	73	116	36	121	39
Suicides.....	12	20	7	10	5
Homicides.....	7	5	2	52	14
War deaths.....	2	5	..	..	..
Cancer.....	70	50	88	31	88
Cerebral hemorrhage, apoplexy.....	68	60	70	77	97
Four communicable diseases of childhood.....					
Measles.....	9	11	9	5	5
Scarlet fever.....	9	11	9	3	2
Whooping cough.....	6	5	6	9	9
Diphtheria and croup.....	24	30	24	10	9
Diarrhea and enteritis.....	26	28	25	26	28
Puerperal state.....	19	..	33	..	49
Puerperal septicemia.....	8	..	14	..	23
Puerperal albuminuria and convulsions.....	5	..	9	..	12
Typhoid fever.....	17	16	13	36	34
Diabetes.....	14	11	19	10	11
Appendicitis.....	12	13	10	14	13
Pellagra.....	4	2	4	6	21
Malaria.....	4	2	2	18	22

5. TUBERCULOSIS

It can be seen very readily from the foregoing table that tuberculosis is still the chief cause of death among wage-earners. The group of organic diseases of the heart is next in importance in the number of deaths, followed by pneumonia—all forms. In the Registration Area of the United States, 1917, on the other hand, organic diseases of the heart is the first group of causes of death followed by pneumonia—all forms, and then by tuberculosis—all forms. Prior to 1915 tuberculosis had been the chief cause of death in the general population, but with the continued downward progress of the tuberculosis rate, organic diseases of the heart assumed the place of first importance. Since then, the rate for organic diseases of the heart has been higher than that for tuberculosis—all forms. In 1915 and 1916, organic diseases of the heart, tuberculosis and pneumonia were the three ranking causes of death in the general population, but in 1917 pneu-

¹ Includes war deaths not shown in above table.

monia displaced tuberculosis as the second cause of death. For the group of insured wage-earners, however, there is still such a gap between the tuberculosis curve and that for organic diseases of the heart that it will be some time before the order of the first three important causes is disturbed, barring years of excessive pneumonia prevalence such as in 1918. The group of colored males showed the highest rate from tuberculosis (430), with colored females next in order (385) followed by white males (212), then by white females (147). These differences in the tuberculosis death rates of the four chief race and sex groups require much detailed examination before conclusions can be drawn. There are, first of all, differences in the age distribution of the several groups and in the types of tuberculosis curves when drawn with respect to age. On page 50 of the book, the authors show two sets of curves for tuberculosis of the lungs. Due reflection upon these curves emphasizes the need for extreme caution in comparing the crude tuberculosis death rates of the several color and sex groups or classes when the data are not displayed for age. It will be seen that the curve for white males is of the middle adult age type with its peak at central age 40. That for colored males is, no doubt, a compound of curves of an early-adult and a middle-adult age type. There is a sharp rise from childhood to a high rate in the age period 20 to 24 years. This figure is maintained practically until central age 40 after which there is a more or less precipitate drop. The curve for white females covers by far the least area, reaches a maximum at central age 30 but resembles no one type of tuberculosis curve. The outline of the curve for colored females, on the other hand, is frankly that of very early adult, perhaps more properly, late adolescent type, with its maximum point at central age 22.5 years, with very sharp descending limbs on both sides of the maximum. The authors suggest that the figures for the age incidence of tuberculosis of the lungs may not represent a single disease entity, but that perhaps all of the curves are compounded of constituents, each representing a certain type of the disease in relation to race, economic status, and other causative factors. There may even be a variety of infecting organisms which may help to account for the differences in the two races at the various age groups.

In the text the authors have simply stated their findings with respect to the incidence of tuberculosis mortality in the several race groups and by sex and age, but admit that it is extremely difficult to say *why* tuberculosis mortality of the negro is higher than that of the

white group, and among males higher than among females. Whether these differences reflect truly the influence of race, or of sex, or whether the explanation lies in environment (sanitation, economic status, occupation, etc.) it is impossible to say. So very much depends upon clinical evidence of the type and characteristics of the disease and upon one's success in evaluating the several factors of inheritance, opportunity for infection, the virulence of the invading and complicating organisms and the important facts of environment such as housing, nutrition, medical care during the incipient state and a host of other important facts. Physical anthropology has before it one of its greatest tasks in showing what bodily measurements are associated in tuberculosis with the several race and sex groups, considered by age, which display such widely different types of mortality curves for a single disease.

Among white male wage-earners, the authors found a lower rate from tuberculosis of the lungs under age 15, and after that age a higher rate than among males in the general population. This was also true for white females in wage earners' families, with the exception of the ages beyond age 65 years.

6. TENDENCY OF TUBERCULOSIS MORTALITY IN THE WHITE AND COLORED RACES

The course of the tuberculosis death rate has been consistently downward during the six years covered by this report and there is no reason to expect any slackening in the tendency toward decline. In 1911, the rate for tuberculosis of the lungs was 203; in 1916, 173 per 100,000 exposed. This represents a decline of 15 per cent. In other words, for every seven deaths from tuberculosis of the lungs in 1911 there was, to correspond, in 1916 only six deaths. This is indeed a satisfactory showing and reflects not only the work of the entire tuberculosis movement but also every other effort toward the improvement of the public health, especially the advancement of the welfare of children.

7. TUBERCULOSIS IN THE NEGRO

Unfortunately, this downward tendency of the tuberculosis death rate of the Industrial Department reflects only the very favorable experience of the group of white lives. Among colored males, there has been a distinct *increase* in the death rate for tuberculosis of the lungs over the period covered by this report. In 1911 the rate was

379 and in 1916, 387 per 100,000. In 1915 a very high rate of 400 per 100,000 was reached for colored males. Although the situation is not so grave among colored females, still, there is no evidence from the statistics of six years that there has been any substantial decline in the rate for tuberculosis of the lungs among this group. It would be conservative to say that the rate for this disease among colored females is practically stationary but that among colored males it has increased at an alarming rate. These sanitary statistics show, for recent years, what has been emphasized by students of negro mortality for the past twenty or more years, namely, that the increasing urbanization of the negro is, and will be for some time to come, productive of high mortality from tuberculosis of the lungs. It is not possible to say, at the present time, whether there is any prospect of checking the increase in the tuberculosis death rate among colored males because of the elimination of individuals unable to survive under the conditions of urban negro life. Students of the health of the several races of mankind, would do well to observe the trend of the tuberculosis death rate of negroes in cities, especially in relation to changes in the age or other outstanding characteristics of the disease.

8. ORGANIC DISEASES OF THE HEART

So far as we may place confidence at present in any statistics of this group of causes of death, the death rate seems to be very much higher among the negroes than among the insured white group. Organic diseases of the heart, however, showed a higher death rate among females of both race groups than among males. From an inspection of the graphic chart given on page 67 of the book, it will be seen that this higher mortality among females of both race groups occurred under 25 years of age. Among white males, after 25 years of age, the death rates for organic diseases of the heart are greater than for white females. It should be noted that up to 54 years among colored females (with one exception, between 25 and 34 years), the death rate for this group of diseases is higher than among colored males. After 55 years of age, the death rate for colored males is the higher.

There seems to be a greater proportionate excess of the death rates of this group of diseases for colored females above white females, than there is for the rates for colored males over those of white males. This will be seen also from the chart given on page 67.

By age periods, the mortality from organic diseases of the heart are much higher among wage earners than among the general population.

The evidence from table 31 is that there seems to be a stationary death rate from this group of organic diseases of the heart. This may be contrasted with the apparently increasing death rate in the Registration Area for deaths in the United States.

9. PNEUMONIA

Diseases caused by acute infections of the respiratory tract have assumed an increasingly menacing place among the causes of mortality. The public health records of important cities of the United States show that the only bacteria-caused disease in the entire category of such diseases, which had higher death rates in these recent years than 30 or 40 years ago, is the pneumonia-bronchitis-influenza group. The statistics given by the authors in Chapter VI will be a small contribution to the historical study of respiratory infections. It should be borne in mind that pneumonia is the most important, numerically, of the acute infectious diseases. It kills every year more people than die of such communicable diseases as measles, scarlet fever, diphtheria, whooping cough and acute poliomyelitis combined. Somehow or other, until the great outbreak of so-called influenza in the fall of 1918, the general public paid but little attention to respiratory disease mortality. The interest aroused in real preventive measures by the pandemic should be maintained and some solution sought to the riddle of mortality from the group of diseases resulting from respiratory infections.

Reverting to the statistics of insured wage-earners, the death rate from pneumonia, lobar and undefined, was considerably higher among colored persons than among white persons. This applies to both sexes. The most striking differences between the mortality of the two race groups from pneumonia—lobar and undefined, occurred between central age 17.5 and 52.5 years. It is shown on the chart on page 75, that there is a slight convexity in the curve for pneumonia—lobar and undefined between central ages 12.5 and 30 years, for both colored males and colored females. Whether this hump in the curve is due to the inclusion of deaths from tuberculous pneumonitis, is doubtful. The volume also gives a discussion of mortality from bronchopneumonia. The graph on page 81 shows that the broncho-pneumonia mortality curve according to ages is "U" shaped and not "J" shaped, as for pneumonia—lobar and undefined. If the statistics for the ages under one year were available, a still higher point would have been shown on the graph for bronchopneumonia, but unfortunately such

data were not at hand in the insurance records. The data for both forms of pneumonia, taken in conjunction with those for influenza, should afford students of the influenza pandemic a considerable amount of material for study.

After 25 years of age, the pneumonia rate is much higher among wage earners than among the general population.

10. OTHER DISEASES AND CONDITIONS

In this abstract a considerable amount of text has been given on the three important groups of causes of death in this experience for wage-earners. In concluding this summary it may be well to comment, briefly, upon the chief facts reported by the authors for the other leading causes of death.

(a) BRIGHT'S DISEASE

The cause of death next in numerical importance was Bright's Disease. As the authors point out on page 87, there is still too much uncertainty in the statistics of Bright's disease, and in fact for the other cardiovascular-renal diseases, that they did not draw any final conclusions on the relative incidence of Bright's disease in the several color, sex and age groups. The statistics, however, are sufficiently good to warrant presentation in detailed tabular form, having in mind always the inherent deficiencies in such statistics of organic diseases. The discussion on page 87, at the beginning of Chapter VII, outlines the reasons why Bright's disease mortality statistics should be viewed with more than ordinary caution. The Bright's disease death rate among both colored males and females, was very much higher than the rates prevailing among white males and white females. These differences are much more pronounced after 35 years of age than earlier in life. The mortality of both groups is, for nearly all age periods, higher among males than among females.

(b) EXTERNAL VIOLENCE

Mortality from accidental and other external causes of death was high. Accidents, including unspecified violence, showed a death rate of 73 per 100,000, suicides a rate of 12, homicides a rate of 7, and war deaths a rate of 2 per 100,000. These mortality rates were higher at most age groups among the group of white insured wage-earners than in the corresponding sex classes of the United States Registration Area for deaths. The figures of accident mortality in the United

States compare very unfavorably with those available for the countries in Europe before the War. Thus, in the year 1913, the fatal accident rate of England and Wales for the age period 35 to 44 years among males, was 62 per 100,000. In the Registration Area of the United States, the rate for males at these ages was 140, and among insured white males, 154 per 100,000. It was pointed out, further, that when the fatal accidents for these three areas were classified according to means of injury, *i.e.*, falls, burns, drowning, steam railroad accidents, etc., the figures for the United States were much above those for England and Wales. The table on page 101 shows that falls were the most frequent of the specified forms of violence, with accidental drowning next in importance and followed by burns, steam railroad accidents and injuries and automobile accidents and injuries. The authors indicate that the death rate from automobile accidents and injuries was progressively on the increase throughout the period under observation and showed that the automobile is a growing menace to the lives of children of the run-about age.

Homicide is an important cause among negroes. It is next to tuberculosis and pneumonia, the chief cause of death among colored males at the period 25 to 34 years.

(c) CANCER

The chapter on cancer statistics is interesting because it presents among other things, a table showing the incidence of the disease in three different economic strata. The authors show, that age being considered, the cancer death rate is higher among the wage earning groups of the population than among those better situated in an economic sense. Furthermore, another important fact brought out in the text is that no real increase in the cancer death rate can be detected from the statistics of insured wage-earners. Students of the cancer problem will profit from a detailed examination of this chapter. It should be noted that the *Journal of Cancer Research* for July, 1919, gives the tabular and text material of this chapter in full.

(d) DISEASES OF THE MATERNAL STATE

The chapter on diseases and conditions associated with the maternal state will also be interesting, especially those that show the possible effect upon maternal mortality of a comprehensive programme of nursing in the puerperal state. The authors show that there was a

decline of 10.7 per cent in the death rate from puerperal diseases and conditions among insured white women in the six years as compared with the practically stationary death rates among women in the Registration Area of the United States.

(e) TYPHOID FEVER

Typhoid fever, a disease which is practically an index of the sanitary intelligence of a community, shows a decline of 43 per cent during the six years covered by this mortality experience for all of the color or sex classes or groups. Rather complete statistics are given for the age and sex incidence of the disease.

(f) OTHER DISEASES

The statistics for diabetes will be of exceedingly great interest to anthropologists because they show that the death rate is higher among wage-earners than among the general population. It has been thought that diabetes was more frequent, and perhaps caused more mortality, among the better situated classes of the community. The age distribution of deaths from diabetes is also of interest. This is shown by the statistics contained on page 229 of the volume. Students interested in the mortality from pellagra and malaria, two diseases found at present very largely in the South, will find complete tables according to color, sex and age and single calendar years in Chapter XVI.

Enough has been given in the way of an abstract to show that this volume contains a great mass of material instructive to students of public health and of the health problems of races. The Metropolitan Life Insurance Company has made it a policy to distribute this volume to research students, to reference libraries and to members of the medical profession interested in data of this kind. While the supply lasts, the Company will continue to give this work to qualified persons who wish to use these data in the furtherance of the study of anthropological, biological and public health problems.

THE NEWEST DISCOVERY OF "ANCIENT" MAN IN
THE UNITED STATES

On July 21, 1919, the Smithsonian Institution received the following letter from a reputable physician:

ZANESVILLE, Ohio, July 19, 1919.

SMITHSONIAN INSTITUTION,
WASHINGTON, D. C.

Dear Sirs:

I write you in regard to a highly important anthropological find made six miles from our city at Gilbert Station within the past week by excavators of the Glacial Sand Company of this city in the glacial drift at that point and at a depth of thirty-two feet below the surface and in a gravel strata.

The find was a skeleton of prehistoric man and measurement was made at once of the length of the body and it measured six feet. The bones crumbled to dust very promptly excepting the skull, which was brought to this city and which I examined today.

The measurements of the skull were from glabella to the spinal foramen, fourteen inches; circumference around the forehead (hat band measure), fourteen inches; from tip of mastoid to tip of mastoid, over top of head, fourteen and one-half inches.

This was an adult as shown from type of body and the fact that the sutures of the skull were grown together. The temporal bone was missing on one side and the lower jaw was missing. There was a shallow frontal sinus and ethmoidal sphenoidal cells were present, also mastoid cells. The petrous part of the temporal bone was about the same shape as in modern skull and semi-circular canals were in same position as in any skull, showing that the lower jaw could not have been that of an ape. There was a hole in the occipital region which was made delicately and evidently with a chisel, like the skulls shown in government reports and books of anthropology published some years ago. Whether this hole was made for surgical purposes to extract arrow-head or whether to let out the evil spirit, I do not know. The skull of the body was facing the east. No signs of syphilis on skull.

I write you at once so that you can immediately come to Zanesville to examine this skull, should you so desire, before it crumbles to dust, as this undoubtedly is a great find. It is in possession of Mr. Henry Buerhaus of the Glacial Sand Company, 17 Richard Block, Zanesville, Ohio.

Very truly yours,

_____, M.D.

P.S. This skull must far antedate Glacial period.

I have sent a copy of above to Curator O. Mills, Columbus, Ohio.

As the Department of Anthropology of the U. S. National Museum, in coöperation with the Bureau of Ethnology, have made it their aim now for many years to carefully examine into every find of this nature made in the United States that seems to be of some importance, and as the above letter was received from a medical man who evidently had some knowledge of anthropology, a telegram was sent to Professor

W. C. Mills, of the Ohio Archæological and Historical Society requesting him to visit Zanesville, examine the remains, and report at once on the results of this examination.

Professor Mills, however, was in the field, and there was no response to the telegram. Efforts were therefore made to have a competent geologist examine the site, which resulted in a visit to the same by Professor Leroy Patton, of the Muskingum College. In addition, the writer sent the following note to our informer at Zanesville:

July 26, 1919

Dear Dr. —————:

This letter should reach you on Monday. If so, kindly telegraph at once, Government Business Collect, brief information on the following points: (1) Are the specimens about which you so kindly notified us still available for examination; (2) has any scientific man been there to see them or the site, or is one expected; (3) does the find still appear important enough to you to warrant my coming to Zanesville; (4) has anything else been found besides the skeletal remains you mentioned in your letter?

Should the case warrant it, I will reach Zanesville on Tuesday evening.

Very truly yours,

A. Hrdlička,

Curator, Div. Physical Anthropology

Shortly after, the following letter was received from Professor Mills:

FLINT RIDGE CAMP, Thursday, July 24, 1919

PROF. W. H. HOLMES,
U. S. National Museum.

Dear Prof. Holmes:

I have your telegram which was forwarded to me here at Flint Ridge, and in a few moments I started for Zanesville, 20 miles to the east. I found Mr. Buerhaus at his office and he turned over the skull in question and I boxed same and forwarded by express and I hope you will receive the package in due time. Mr. Buerhaus presents same to the Museum and I hope you will acknowledge receipt and give him your opinion concerning the skull. My own opinion is that the skull is adult female (Indian), found in a deposit of river gravel. I did not have time to visit the place but if the skull proves other I will gladly go and inspect the entire region although I have been along the river many times and feel assured in my own mind concerning the location. I have a number of men at work opening the old quarries and felt compelled to return at the earliest time possible.

Very truly yours,

W. C. Mills

The skull came promptly, and after examination the following report on it was sent to the donor:

July 30, 1919

MR. A. H. BUERHAUS,
Glacial Sand and Gravel Co.,
Zanesville, Ohio.

Dear Sir:

According to your wish I herewith submit a brief report on the human skull which you had the kindness to send us last week:

The skull is that of an adult female subject, probably Indian; but the possibility of it being White cannot be excluded.

The specimen is so damaged that very little besides this can be said about it. The hole in the back part is not due to an operation, but evidently to an abrasion.

The specimen shows no signs whatever of antiquity.

Should any other human remains be found in the work under your direction, kindly preserve the bones for us.

Very truly yours,

A. Hrdlička,
Curator, Div. Physical Anthropology

Meanwhile, a telegram and several notes were received from our original informer to the effect that the find had upon critical examination by Professors Mills and Patton lost much of its importance; and a few days later the following detailed report on the find was received from Prof. Patton:

ON THE HUMAN REMAINS IN PLEISTOCENE DEPOSITS AT GILBERT, OHIO

On the nineteenth of July of this year announcement was made through the medium of the public press of the finding of a skeleton of a human being near Zanesville, Ohio, in deposits which were said to prove the remains to be of Pleistocene or earlier age. Immediately upon reading the press reports the writer, recognizing the possible importance of the matter, went at once to Gilbert where the skeleton had been discovered and made as thorough an investigation of the circumstances as possible.

It was learned that the skeleton had been found in the pit of the Glacial Sand and Gravel Company several weeks previous. After being removed to the office of Mr. Henry Buerhaus, treasurer of the company, at Zanesville, it attracted the attention of some persons interested in geology and anthropology in an amateur way and also other persons interested in news with the result that considerable publicity was given to the matter and the find was heralded as proving the existence of man in this region in glacial or pre-glacial times.

The skeleton was found by Mr. Cleve Hunter, foreman of company at Gilbert works. Mr. Hunter went over the ground carefully with

the writer and gave a complete and detailed account of the circumstances under which the remains were found. The writer desires to state that he found Mr. Hunter an intelligent man, thoroughly honest and straightforward and interested only in giving the facts as he knew them.

The Glacial Sand and Gravel Company is obtaining material at this place from a terrace of sand and gravel in the valley of the Muskingum River on the east side of the river one eighth of a mile north of the Pennsylvania R. R. station at Gilbert. The top of this Terrace is 773 feet A.T., the river at this place being 700 feet A.T. The material of the terrace consists of alternating layers of sand and gravel, the sand exhibiting marked cross-bedding practically throughout the whole of the exposure. The terrace is a part of the deposits described by Leverett as a valley train, probably of Wisconsin age.¹

Sand and gravel is removed from the terrace by means of a steam shovel which is located at the base of the terrace. Operations have exposed the face of the terrace for a distance of two or three hundred yards and as excavations are made down to water level a vertical face of about seventy-five feet is exposed. Sand and gravel have been taken from this terrace for a number of years, this deposit having been worked by several different firms. The base of the terrace at this place is now considerably further east from the river than formerly as a result of these operations.

The material of the terrace stands up in steep faces in some places in the exposure and in others slumps down to the angle of repose.

Fourteen feet from the top of the exposure there is a rather persistent layer of sandy clay which stands up better than the rest of the material and forms miniature terraces in many places. The sand and gravel slumping down from above lodge on this shelf and the material piles up at an angle of repose. About five feet above the clay stratum there is a layer of dark carbonaceous material. This is also persistent and is seen throughout the exposure.

Mr. Hunter stated that the remains were found above the clay stratum and at an elevation lower than that of the line of carbonaceous material. Asked to point out a situation which resembled as nearly as possible the situation in which the remains were found he unhesitatingly indicated one of the miniature terraces described above and said that he first saw the skull protruding from the loose sand and gravel

¹ Leverett, Frank, Monograph XLI, U. S. Geol. Sur., "Glacial Formations and Drainage Features of the Erie and Ohio River Basins," p. 157.

piled up on the ledge. It should be noted here that according to Mr. Hunter's testimony that although he recalls the location of the remains with reference to the clay stratum and the layer of carbonaceous material, that the material above the clay stratum was not in place over the remains when they were found. The skeleton was lying roughly parallel to the edge of the ledge when found. Underneath, between it and the clay stratum was perhaps a foot of material. Whether this was the original material deposited on top of the clay stratum or material which had fallen from above could not be determined. It seemed clear, however, from Mr. Hunter's testimony that the material which covered the skeleton was loose material which had fallen from above. This point was made especially clear upon the writer's request to have a geology hammer placed in a deposit of the kind which would show as nearly as possible the conditions under which the skeleton was found. He directed that the hammer be placed in what was unmistakably loose material which had slumped down from above.

The writer inquired into the possibility of part of the skeleton being on the ledge with none of the original material being in place over it and part being in the undisturbed stratified material of the face of the exposure. Nothing can be proved as to this, however, as Mr. Hunter cannot state whether it was necessary to dig into any of the undisturbed stratified material as he did not take critical notice of condition.

It seems clear, however, from Mr. Hunter's testimony that at least a greater part of the skeleton was found in loose material and there is no evidence to prove that it was not wholly in this kind of material.

The position of the skeleton when found in the material above this clay stratum would make its location about thirteen feet below the top of the exposure. Allowing for about two feet of stripping which has taken place the maximum depth from the original surface to the place where the skeleton was found would be not more than fifteen feet. This is an unusual but not a prohibitive depth for interment and there is no evidence here to prove that the remains were not interred in these deposits at this depth. It seems to the writer more probable, however, that the remains were interred at a less depth than this and that together with the material in which they were interred they had slumped down from above and lodged on the ledge on which they were found.

The theory of the interment of these remains is further strengthened by several other circumstances. Mrs. Pamela White, owner of the

land in question and who has lived here for over forty years, says that when she first came to this place that there were, upon the site where the remains were found, a few stones rudely shaped like tombstones and set in the ground after the manner of placing tombstones. There were some marks on the stones but, either because the characters were nearly obliterated by time or because they were characters the significance of which was not known, nothing could be learned from them. Nothing was known concerning the history of these stones or whether anyone was buried there. The stones were subsequently removed and their existence all but forgotten.

The probability of several people being buried here is further strengthened by the fact that other bones have been found in the pit, although the case under discussion is the only instance of the finding of a nearly complete skeleton.

However, irrespective of the suggestion of a possible burying ground at this place, there seems to be no geological evidence in this case that the remains were deposited in the fluvio-glacial at the time this material was laid down since it is not proved that the remains were found in undisturbed material and overlain by undisturbed fluvio-glacial deposits. On the other hand all of the circumstances point to other and more probable solutions.

The writer does not base any of his conclusions upon an examination of the remains themselves, having confined his investigations wholly to the geological conditions under which the remains were found.

Immediately upon the conclusion of his investigations the writer sent a brief report to the state geologist and also issued a statement to the press to the effect that there is no geological evidence whatever that these remains are of Pleistocene or earlier age.

The whole affair is obviously the result of the misguided enthusiasm of some amateur scientific investigators and clever press agent co-operation on the part of over-zealous newspaper writers.

DEPARTMENT OF GEOLOGY,
MUSKINGUM COLLEGE

LEROY PATTON

As a finishing touch to the history of the Zanesville find may be quoted a part of the last letter received from Dr. —, which reads thus:

"The first article in our local paper (The Signal) was written by a local reporter (you did not see that article) in which it stated the skeleton was found in Glacial drift and was probably 20,000 years old. This was surmise of reporter or owner of sand bank. After the appearance of that article I examined the skull and measured it. It was so small and the report coming from the man who dug the skeleton out

that the body was 6 feet long made me surmise that the skeleton must have been something unusual with such a very small skull to a six foot body. Also, the first report was that the body was 30 feet below surface."

The case represents a fortunate occurrence of the usual initial exaggeration by newspapers and non-experts, with a prompt, sober, scientific examination of conditions. Had some less qualified persons become interested in the find before Professors Patton and Mills could reach the site another item might easily have been added to the already long list of ambiguous examples by which a geological antiquity of man in America is supported.

A. H.

INFLUENZA AMONG THE AMERICAN INDIANS

By the Public Health Service

The following tables were compiled by the Public Health Service from data furnished by the Commissioner of Indian Affairs. They

CASES OF INFLUENZA AMONG INDIANS, OCT. 1, 1918, TO JUNE 30, 1919

State	Population	Cases			Cases per 1,000 Pop- ulation
		Minors	Adults	Total	
Arizona.....	45,707	9,390	7,847	17,237	377.1
California.....	16,416	2,010	2,388	4,398	267.9
Colorado.....	1,222	333	157	490	401.0
Florida.....	585	20	46	66	112.8
Idaho.....	4,208	243	407	650	154.5
Iowa.....	356	90	35	125	351.1
Kansas.....	2,275	625	235	860	378.0
Michigan.....	1,097	25	25	50	45.6
Minnesota.....	12,003	1,311	741	2,052	171.0
Mississippi.....	1,253	217	432	649	518.0
Montana.....	12,079	1,111	1,021	2,132	176.5
Nebraska.....	2,834	470	391	861	303.8
Nevada.....	11,190	848	2,746	3,594	321.2
New Mexico.....	22,005	5,410	5,561	10,971	498.6
New York.....	5,982	400	400	800	133.7
North Carolina.....	2,343	409	372	781	333.3
North Dakota.....	9,216	1,631	718	2,349	254.9
Oklahoma.....	118,227	6,530	8,697	15,227	128.8
Oregon.....	4,355	661	436	1,097	251.9
South Dakota.....	23,890	4,595	3,964	8,559	358.3
Utah.....	1,704	201	281	482	282.9
Washington.....	10,315	824	1,197	2,021	195.9
Wisconsin.....	9,696	1,601	1,109	2,710	279.5
Wyoming.....	1,696	1	15	16	9.4
Total.....	320,654	38,956	39,221	78,177	243.8

¹ Includes estimate of 3,000 unenrolled Indians in Nevada and 5,000 in California belonging to the Reno Agency.

show the number of cases of influenza reported among Indians on reservations in the United States, and deaths due to the disease; also morbidity, mortality, and case fatality rates.—*Publ. Health Rep's*, Oct. 17, 1919.

Confirmation of reports that the native Indian population of Bristol Bay, Alaska, virtually was wiped out by an epidemic of influenza has been brought to San Francisco with the return of the United States cruiser *Marblehead* from a relief expedition to the north.

According to Lieut. W. R. Leahy, senior medical officer of the expedition, 95 per cent of a population of more than 900 persons had died by the time the expedition reached Bristol Bay.

Deaths from influenza among Indians, October 1, 1918, to June 30, 1919

State	Deaths				
	Minors	Adults	Total	Deaths per 1,000 Population	Fatalities per 100 Cases
Arizona.....	1,027	921	1,948	42.6	11.3
California.....	123	133	256	15.6	5.8
Colorado.....	35	24	59	48.2	12.0
Florida.....	3	7	10	17.1	15.1
Idaho.....	21	54	75	17.8	11.5
Iowa.....	5	4	9	25.3	7.2
Kansas.....	13	7	20	8.8	2.3
Michigan.....	1	1	2	1.8	4.0
Minnesota.....	65	57	122	10.2	5.9
Mississippi.....	18	43	61	48.7	9.4
Montana.....	59	80	139	11.5	6.5
Nebraska.....	26	34	60	21.2	6.9
Nevada.....	52	219	271	24.2	7.5
New Mexico.....	635	610	1,245	56.6	11.3
New York.....	40	40	80	13.4	10.0
North Carolina.....	25	12	37	15.8	4.7
North Dakota.....	48	72	120	13.0	5.1
Oklahoma.....	330	531	861	7.3	5.7
Oregon.....	45	49	94	21.6	8.6
South Dakota.....	365	390	755	31.6	8.8
Utah.....	25	52	77	45.1	15.9
Washington.....	89	83	172	16.7	8.5
Wisconsin.....	71	87	158	16.3	5.8
Wyoming.....	0	1	1	.6	6.3
Total.....	3,121	3,511	6,632	20.7	8.5

TUBERCULOSIS AMONG THE NATIVES IN THE WEST INDIES

The death-rate from tuberculosis among the colored population in some of the West Indian islands has in the past been exceedingly high. The persistent efforts of the white residents in Trinidad, Tobago, the Guianas and elsewhere, and especially the organized

campaign of the Association for Prevention and Treatment of Tuberculosis, have reduced this mortality by nearly 50 per cent since 1905; nevertheless the death-rate from the disease is still far too high, being in Trinidad little short of 30 per 1000. It has been definitely established however that the West Indian native, if treated on rational lines in the early stages of the disease, seems to be quite as capable of recovery as is the British patient.—*Brit. Med. J.*, May 31, 1919, 683.

SEX DETERMINATION

In an effort to test the correctness of Dawson's theory that sex is determined by the supplying ovary, males being produced by fertilization of an ovum from the left ovary, Dr. John J. Murray, Jr., has gone over the records of 17,500 deliveries which occurred in the Obstetric Clinic of the Johns Hopkins Hospital between September, 1896, and March, 1918. (*Johns Hopkins Hospital Bulletin*, December, 1918, pp. 275-281.) There were 75 cases (70 women, five of them having two pregnancies), in which the location of the corpus luteum was determined by Caesarean section, by laparotomy, or by post mortem, and in which there was no doubt as to the sex of the child. Murray found that "male and female children result in about equal numbers from the fertilization of ova from either ovary" and that consequently Dawson's theory is proved to be incorrect. He concludes that "the causation of sex is probably not due to any factor in the unfertilized ovum"; that "the 'chromosome theory' must be considered the only explanation of sex at present acceptable"; and that "the sex of an unborn child cannot be foretold, nor can either sex be produced at will, by any rules known at present."—*Eugenical News*, June, 1919.

It may be recalled in this connection that similar results were in 1911 obtained experimentally by Dean on albino rats: Dean (H. K.)—The effects of semi-spaying and semi-castration on the sex ratio of the albino rat.—*J. Exp. Zool.*, May, 1911, X, 381-392.

HEREDITY IN TWINS

Professor Kristine Bonnevie has published as Contribution No. 2 from the University (of Christiana) Institute for Investigation in Heredity a paper entitled "On Tvillingsfodslers Arvelighet," or "On the Inheritance of Twin Births." A certain rural family shows about three times the normal proportion of twin births in a population of

about 5,000 individuals. In the special "twin branches," the proportion of multiple births rises to 7.7 per cent, or six times the average. The author concludes that among younger mothers, below 30 years, 1- and 2-egg twins are about equally numerous, while the twins borne by older mothers are practically all from 2 eggs. The proportion of 2-egg twins to 1-egg twins in the family is about 4: 1, and it is in double egg twin births that inheritance is most clearly shown. Out of 88 twin-producing mothers, 67 (the best known) are without exception shown to descend from twin families through both parents or through the one parent who is known. "The hereditary nature of the disposition for double-egg twin births is thus proved without doubt. Its types of heredity seem, further, to be that of a *recessive character*, demanding for its manifestation that the twin mother should receive her disposition in a double dose through both her parents. The twins seem, among their brothers and sisters, not to be predisposed to twinning."—*Eugenical News*, Nov., 1919.

MORTALITY OF INFANTS OF DIFFERENT RACIAL GROUPS

In the *New England Medical Gazette*, vol. 52, page 366, Dr. F. H. MacCarthy gives the following table of death rates of infants under one year per thousand births from the three principal causes of infant mortality grouped according to nationality of mothers.

Causes of Death	U. S.	Canada	Ireland	Italy	Russia and Poland
Congenital debility.....	36.37	30.00	26.08	13.00	20.00
Gastro-enteritis.....	20.60	14.63	16.56	19.58	15.78
Pneumonia.....	13.09	15.29	12.83	29.53	19.62

CURRENT NOTES

The Anthropological Society of St. Louis.—On January 2, there has been organized in St. Louis *The Anthropological Society of St. Louis*. The membership of the Society consists essentially of the local anatomists and prominent medical men interested in anthropological research; but its interests will comprise the whole field of anthropology. Professor R. J. Terry has been elected the first President of the Society.

Mr. George G. Heye, director of the Museum of the American Indian, Heye Foundation, announces that the department of physical anthropology, which had to be closed during the period of the war, has again resumed active work under the direction of the same staff, namely, Dr. James B. Clemens and Dr. Bruno Oettinger. The department has now separate housing accommodations at 11 St. Nicholas Place, corner of 150th Street, which suits its present needs.

Dr. Hrdlička left Washington early in January for the Far East, in the interests of his studies on the origin of the American Indian, and in those of anthropological work in China and Hawaii. He expects to be back in June. The JOURNAL will meanwhile be in the hands of Dr. Gerrit S. Miller, curator of the Division of Mammals, U. S. National Museum.

As the JOURNAL was going to press it became known that the XX International Congress of Americanists, which was to have met at Rio de Janeiro in June of this year, has been indefinitely postponed. The reason given is that the unsettled world conditions prevent European representatives from attending. It has been intimated that the next Congress will meet in 1922.

Dr. A. A. Mendes Corrêa, formerly assistant of the faculty of science of the University of Oporto where he was teaching anthropology since 1912, has been some time ago proposed by the faculty for the vacant place of ordinary professor. A faculty of letters having been lately founded in the University, Dr. Mendes Corrêa was named ordinary professor of the new faculty for the group of geographical sciences which include anthropology.

From the daily press we learn that Dr. and Mrs. Gustaf Dolinder, the former a leading Swedish scientist, sailed for South America early in January. They expect to remain one year, engaged in general ethnographic and archeological investigations; considerable attention will later be devoted to the Indian tribes of the Magdalen River region.

Dr. Franz Boas late in December tendered his resignation as one of the representatives of the American Anthropological Association on the Committee of Anthropology and Psychology of the National Research Council.

Ludwig Stieda. ✕—Belated German periodicals bring the announcement of the death of Dr. L. S. Stieda, emeritus professor of anatomy at the Königsberg University. He died in 1918, in his eighty-second year. Physical anthropology owes a debt to Professor Stieda for his lifelong interest in the science, and for his very useful annual reviews of Russian anthropological literature, published periodically for many years in the *Archiv für Anthropologie*.

Richard Lynch Garner. ✕—Professor Garner, who was widely known through his investigations among the anthropoid apes, died suddenly at Chattanooga, Tennessee, on January 23, 1920. He was an indefatigable worker, and has contributed greatly to our knowledge of the life and habits of the apes.

Horatio C. Wood. ✕—*Science* reports the death, on January 3, of Horatio C. Wood, M. D., LL. D., emeritus professor of materia medica, pharmacy and general therapeutics in the University of Pennsylvania Medical School.

NOTES FROM THE FAR EAST

Dr. J. G. Andersson, of the Chinese Geological Survey, has loaned a number of human skeletons from Chihli Province excavations to the anthropological department of the Peking Union Medical College. Dr. E. H. Tang, president of the Government Special Medical School in Peking, has also loaned his valuable series of Chihli Province crania to the anthropological department of the college.

Père Florent De Preter, of the Belgian Mission at Chin-Chow, who has been decorated by the Chinese government for his ethnological work in Manchuria, has recently visited Peking. Arrangements for the despatch of an expedition by the department of anthropology, P. U. M. C., to investigate the cave burials in the vicinity of Chin-Chow have been greatly facilitated by Père De Preter's cordial coöperation.

Mr. Roy C. Andrews, of the American Museum of Natural History, has obtained a number of human crania from the vicinity of Urga. Mr. Andrews experienced the greatest difficulty in collecting and transporting this material owing to the present unsettled condition of that part of Mongolia.

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CONFLICTING VIEWS ON THE PROBLEM OF MAN'S ANCESTRY

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Writers who have recently dealt with the problem of man's ancestry have expressed opinions which strikingly contrast with each other. It has seemed of interest to bring together some of the more important of these conflicting views and to add to them a few of my own observations and conjectures.

INCOMPLETENESS OF THE GEOLOGICAL RECORD

Paleontology is at present unable to furnish the conclusive direct evidence needed to answer the question: From what particular primate stock did the line of human ancestry take its origin? This failure is the result of the fact that every known fossil which might be expected to supply such evidence represents either: (1) remains that are definitely those of men, (2) remains that are definitely those of apes, or (3) remains whose characters are for various reasons so inconclusive that the systematic position of the creatures to which they belonged has not yet been finally determined. With regard to all this evidence two of the main sources of difficulty are that the bones usually consist of mere fragments, and that the parts of the skeleton most likely to be preserved through fossilization are those which furnish the least important characters. In the skull the fragile basicranial and facial regions are easily lost, while the calvarium shows relatively great powers of resistance. But the actual processes

by which the skull acquired its human structure are to be sought much less in the modelling of the skull cap than in the profound basi-cranial and facial adjustments by means of which it has been made possible for the head with its enlarged brain to be balanced on top of the upright vertebral column. Similarly with the limbs; the somewhat unimportant long bones may easily be preserved under circumstances which would destroy such essential parts as the hand, foot, wrist and ankle, whose specialization must mark the real course pursued by the early representatives of the human stock in gradually attaining their distinctive structure. The cheekteeth, as might be anticipated, are the parts of the body most frequently found. In all of the higher primates, however, the structural features of the molars are fundamentally uniform, and little removed from the primitive tritubercular type. They are furthermore of a kind which easily leads to the development of similiar crown forms in animals which are not nearly related. Taken alone, therefore, these teeth are of limited value in tracing the direction of evolution.

The fact that the characters shown by a few teeth and fragments of bone do not necessarily furnish a clue to the structure of an entire animal cannot be too strongly emphasized in the present connection.¹ A skull cap, a leg bone, or some molars might possess characters exactly intermediate between those of man and those of a given anthropoid or other primate; but we would have no means of knowing, in the absence of the rest of the skeleton, that the structure of other parts of the animal from which the fragments came had been equally intermediate and that the creature did in fact represent a link in the chain of human evolution. All that can be safely concluded as to the characters of such isolated portions of the skeleton is that they represent plastic stages through which certain human peculiarities could have been derived from certain simian peculiarities. Yet there is a tendency to think, speak, and write of the extinct higher primates as if they were actually known as animals, in the sense that some fossil members of other mammalian families, the horses, for instance, are known. Only in the case of Neanderthal man could such a course be justified. Definite knowledge of the genetic relationships and evolutionary meaning of all the others must await the finding of skeletons sufficiently perfect to include most of the

¹ A suggestive paper on this general subject has recently been published by B. Petronievics: *La loi de l'Évolution non corrélative*, *Révue Générale des Sciences*, April 30, 1919, XXX, 240-242.

cardinal parts.¹ Until such discoveries are made the incompleteness of the geological record should be kept constantly in mind. The following rough list of the described parts of the fossil primates whose characters might be hoped to aid in solving the problem of man's ancestry may give this phase of the subject some of the prominence which it deserves.

MEN

Heidelberg man—Mandible with its teeth.

Neanderthal man—Most of the skeleton.

Exact position not finally determined:

Eoanthropus—Fragments of braincase; squamosal; nasals; one canine tooth; imperfect mandible with first and second molars. Not certainly parts of one animal.²

Pithecanthropus—Skull cap; third upper molar; femur. Not certainly parts of one animal.¹

APES

Anthropodus—Jugal; upper incisor.

Dryopithecus—Most of the teeth; maxilla; lower jaw.

Griphopithecus—Third upper molar.

Neopithecus—Third lower molar.

Palæopithecus—Palate and upper teeth (except incisors).

Palæosimia—Third upper molar.

Parapithecus—Mandible with its teeth.

Pliohylobates—Femur.

Pliopithecus—Mandible with its teeth; palate and upper teeth.

Propliopithecus—Mandible with its teeth.

Sivapithecus—Two fragments of lower jaws, one containing three perfect cheekteeth, the other containing the canine and the roots of two incisors and one premolar; a few cheekteeth, among them the first and second upper molars set in a small piece of the maxilla.

In the presence of so little real information as to the structure of extinct higher primates the treatment of the subject under discussion inevitably resolves itself into the making of hypotheses based chiefly on the facts of comparative anatomy, physiology and embryology of the living members of the group. Speculation as to the early history of the human line cannot therefore do otherwise than lead to widely divergent results.

¹ "La solution du problème de nos origines et surtout la détermination précise de notre lignée exigent de nouvelles découvertes de fossiles, de nombreux fossiles!" (Boule).

² See Ramström, *Bull. Geol. Inst. Upsala*, 1919, XVI, 301-302.

SIMPLE OR MULTIPLE ORIGIN

By some writers it is asserted that the various living and fossil members of the family *Hominidæ* are not, as usually believed, comparatively recent offshoots from a common stem, but that the uniform general structure of all known men is due less to intimate relationship than to convergence, that is, to the equalizing effect on originally unlike animals of the long action of uniform molding forces. There are two principal forms in which this idea has been expressed.

One is set forth by Klaatsch.¹ After describing and figuring the likenesses which he finds between the long bones and the skulls of Neanderthal man and the gorilla on the one hand, and Aurignacian man and the orang on the other, he concludes (p. 97) that it is necessary to assume the existence of two great "streams" of pre-humanity, a western and an eastern, each of which independently gave rise to races of men and to great apes. Neanderthal man and the gorilla are representatives of the western stream, Aurignacian man and the orang are representatives of the eastern. Between these two apes or these two men the relationship is less intimate than that between the ape and the man developed from each stream. To express this relationship he designates the first pair as the "N-G-type," the second as the "A-O-type." The resemblances on which this hypothesis rests are confined to such superficial and unimportant characters, particularly as regards the skull, that it is impossible to regard Klaatsch's conjectures as serious contributions to an understanding of the subject of man's origin. Keith² in particular has shown their worthlessness.

The other is elaborately developed by Sergi in various papers, but principally in his two books *Le Origini Umane* 1913, and *L'Evoluzione Organica e le Origini Umane*, 1914. It is based on the general conception that organic evolution is mainly the result of a process which may be described as a succession or superposition of groups (*stirpi*). The members of any group living at a given time have, according to this view, been chiefly derived from equivalent members of a geologically preceding group. The branches of the genealogical tree are therefore mostly parallel. They change their characters as they grow upward, and the branches may subdivide into secondary parallel branches "according to their own vitality and the conditions under

¹ "Menschenrassen und Menschenaffen," *Korr.-Blatt Deutsch. Gesellsch. Anthropol.*, July, 1910, XLI, 91-100, Figs. 1-14.

² *Nature*, December 15, 1910, LXXXV, 206, and February, 16, 1911, LXXXV, 509-510.

which they live," but they do not spread from common centers of radiation. As applied to those of the primates under special discussion that are represented by fossil forms the plan works out as follows. From the unknown predecessors of the primates arose the three independent groups, *Cercopithecidae* with six independent branches, *Simiidae* with four branches, and *Hominidae* with four branches. Each of the four branches of the *Hominidae* is regarded as a genus: *Eoanthropus*, *Palæanthropus* (*heidelbergensis*), *Notanthropus* (negro) and *Heoanthropus* (Mongolian). These genera are not derived from a common, earlier, less specialized human type, neither are they connected with the great apes or with other known primates. Each is supposed to have been distinct since the hominid group originated from its hypothetical forerunners. There appears to be small likelihood that the ideas of Sergi will meet with general acceptance. They have been severely and, it seems, justly criticized by Giuffrida-Ruggeri.¹ Yet it must be admitted that they partly rest on two facts or circumstances which are recognized sources of difficulty to the more usual conception of the course of evolutionary history: the Minerva-like manner in which whole faunas suddenly appear in the geological record with complete panoplies of species, genera, and families, and the steadily increasing number of supposedly modern types whose range is being found to extend unexpectedly far into the past.

The known types of men resemble each other so closely in both the generalized and specialized parts of their structure that, as Giuffrida-Ruggeri has remarked, there can be no real basis for speculation as to their origin by polyphyletic or polygenetic types of evolution. Certainly no such ideas would be suggested with regard to any other group of mammals in which an equal degree of uniformity prevailed. Hence there seems to be no reason to abandon the generally accepted opinion that the entire human family is descended from a common ancestry. As to the nature of this ancestral stock and its probable geological history there is little uniformity of opinion. Two main hypotheses, however, represent in a general way the views of most of the more recent writers. They are: (1) that the human line of descent goes back, in relatively late geological time, to a stock that had first become so definitely simian that its representatives would be placed in the same family as the existing great apes, and (2) that the human line took its origin at an early period from *Tarsius*-like animals and

¹ "Unicità del Philum Umano con pluralità dei Centri Specifici," *Rev. Ital. Paleont.*, 1918, XXIV, 3-11.

that throughout its subsequent course it has been distinct from the lines of the apes and monkeys.¹ The first may be called the Simian hypothesis, the second the Tarsin hypothesis.

THE SIMIAN HYPOTHESIS

The Simian hypothesis may be considered as the accepted view of the subject. With variations in details it underlies the great mass of recent work. While the evidence on which it rests has been frequently discussed it has probably been most fully and clearly presented in the second part of the "Studies on the Evolution of the Primates," by Dr. William K. Gregory.²

"A new synthetic study of the Primates," this author says, "seems timely because of the great additions that have been made during the last two decades to the material or objective side of our knowledge of the Primates. For during this period the Eocene lemuroids have been revised by Osborn (1902), Wortman (1903-1904), Stehlin (1912), and Matthew (1915), while new extinct lemurs of Madagascar have been described by Grandidier (1905), Standing (1908), and others. The fossil anthropoids of Europe have been restudied by Schlosser (1900, 1903), and Abel (1902), and the paleontological history of this group has been recently extended by the discoveries of Pilgrim (1915) in India and of Schlosser (1911) and Stromer in Egypt. Meanwhile great progress has been made in the knowledge of Pleistocene races of man, especially through the labors of Gorjanovic-Kramberger (1906), Schoetensack (1908), Boule (1912), Schwalbe (in numerous studies), Smith Woodward (1913), Keith (1915) and others."

The scope of Doctor Gregory's paper is indicated by its table of contents: I. Introduction; II. Chief adaptive characters of the skull, dentition and limbs of the recent anthropoids and man; III. The Fayûm Oligocene anthropoids (*Parapithecus*, *Propliopithecus*); IV. The Siwalik Upper Miocene and Lower Pliocene anthropoids (*Palæosimia*, *Sivapithecus*, *Dryopithecus*, *Palæopithecus*); V. The extinct anthropoids and men of Europe; also *Pithecanthropus* (*Pliopithecus*, *Dryopithecus*, *Neopithecus*, *Pan*, *Pithecanthropus*, *Homo*); VI. Phylo-

¹ An intermediate position is taken by Boule (*L'Homme fossile de la Chapelle-aux-Saints*, 1913, 268). He regards the human line as entirely distinct from that of the great apes, but as having probably originated from the same common primate stock as the apes and monkeys.

² "Phylogeny of Recent and Extinct Anthropoids with Special Reference to the Origin of Man," *Bull. Amer. Mus. Nat. Hist.*, June 16, 1916, XXXV, 258-355.

genetic summary and conclusions. Thirty-five text figures give a clear idea of the more important of the fossil remains which form the basis of present knowledge of the extinct anthropoids. The author summarizes his conclusions as follows (pp. 341-342):

"1. Comparative anatomical (including embryological) evidence alone has shown that man and the anthropoids have been derived from a primitive anthropoid stock and that man's nearest existing relatives are the chimpanzee and gorilla.

"2. The chimpanzee and gorilla have retained, with only minor changes the ancestral habits and habitus in brain, dentition, skull and limbs, while the forerunners of the *Hominidæ*, through a profound change in function, lost the primitive anthropoid habitus, gave up arboreal frugivorous adaptations and early became terrestrial, bipedal and predatory, using crude flints to cut up and smash the varied food.

"3. The ancestral chimpanzee-gorilla-man stock appears to be represented by the Upper Miocene genera *Sivapithecus* and *Dryopithecus*, the former more closely allied to, or directly ancestral to, the *Hominidæ*, the latter to chimpanzee and gorilla. On page 327 he adds: "I believe that a concrete and approximately accurate notion of the facts would be given if one were to affirm that the Upper Miocene ancestors of the *Hominidæ* were at least very closely akin to the Upper Miocene common ancestors of the chimpanzee and gorilla, that they were in fact heavy-jawed, stout limbed, tailless and semi-erect anthropoid Catarrhinæ, with quadritubercular second and third upper molars and *Sivapithecus*-like lower molars." In the diagram on page 337 the human line is shown as branching off from the "*Simiinae*."

"4. Many of the differences that separate man from anthropoids of the *Sivapithecus* type are retrogressive changes, following the profound change in food habits above noted. Here belong the retraction of the face and dental arch, the reduction in size of the canines, the reduction of the jaw muscles, the loss of the prehensile character of the hallux. Many other differences are secondary adjustments in relative proportions, connected with the change from semi-arboreal, semi-erect and semi-quadrupedal progression to fully terrestrial bipedal progression. The earliest anthropoids being of small size doubtless had slender limbs; later semi-terrestrial semi-erect forms were probably not unlike a very young gorilla, with fairly short legs and not excessively elongate arms. The long legs and short arms of man are due, I believe, to a secondary readjustment of proportions. The

very short legs and very long arms of old male gorillas may well be a specialization.

"5. At present I know no good evidence for believing that the separation of the *Hominidæ* from the *Simiidæ* took place any earlier than the Miocene, and probably the Upper Miocene. The change in structure during this vast interval (two or more million years) is much greater in the *Hominidæ* than in the conservative anthropoids, but it is not unlikely that during a profound change of life habits evolution sometimes proceeds more rapidly than in the more familiar cases where uninterrupted progressive adaptations proceed in a single direction.

"6. *Homo heidelbergensis* appears to be directly ancestral to all the later *Hominidæ*."

THE TARSIAN HYPOTHESIS

The tarsian hypothesis has been explained by Prof. Frederic Wood-Jones in a pamphlet¹ intended "for a public wider than that represented by those few who attend the meetings of scientific societies." As it is not very generally known I shall give a rather detailed synopsis.

"Before we attempt to follow the story of the evolution of man as a zoölogical type" Professor Wood-Jones remarks, "it is necessary that we follow the evolution of ideas upon the subject. . . ." The first half of the pamphlet is therefore devoted to a rapid survey of the growth of opinion from Aristotle to Gregory. Briefly stated the two main results of this growth are, (a) that man is regarded as a product of evolution, and (b) that while "end-on" evolution, or the direct passage from the highest representatives of a lower type to the lowest representatives of a higher type, is generally discredited as applied to most organisms "we still retain a belief in the 'end-on' evolution of man *via* the stages of the lower quadrupedal mammal, lemur, monkey, and anthropoid ape. It is this belief that determines the modern method of research in comparative anatomy, for if the history of any human structure is sought, its condition of development is examined in the anthropoid apes, in the monkeys of the Old World and of the New World, then in the lemurs, and finally in some common quadruped."

In criticizing this method of study Professor Wood-Jones first eliminates the ordinary quadrupeds from the line of man's descent.

¹ The Problem of Man's Ancestry. By Wood-Jones (Frederic), Professor of Anatomy in the University of London. 12°, London, Society for Promoting Christian Knowledge, 1918, pp. 1-48. Price 7d.

"It is enough to study the hand and forearm of man to note the astonishingly primitive arrangement of bones, muscles and joints, to compare them with those of a primitive type of reptile [in which the limbs serve for propulsion but not for support], and to contrast them with those of a quadrupedal mammal, to be certain that at no period has man or his ancestors supported the body weight upon the fore limb, resting upon the surface of the earth.¹ It is therefore hopeless to expect light on man's origin from the study of such an animal as a typical quadrupedal mammal." The lemurs other than *Tarsius* are next considered. As long ago as 1873 Mivart expressed the opinion that it is "in the highest degree improbable that the lemuroids and apes took origin from any common root form not equally a progenitor of other mammalian orders." This idea is now elaborated and brought to the conclusion that "the primitive lemurs and the primitive monkeys resemble each other simply because they are both representatives of exceedingly primitive arboreal mammalian stocks; but here the likeness ends, and the lemur group can certainly not be regarded as belonging to or even ancestral of, the monkey group." Finally as to the monkeys and apes; man differs from these animals in three general directions. "In the first place he does not possess several features which we may term pithecoïd or simian specializations. In the second he retains a remarkably large number of very primitive features which have been lost by the monkeys and anthropoid apes. And in the third, he has developed some distinctly human specializations, some of which are dependent upon his upright posture, but some are quite independent of this factor. The features embraced in the first category are not capable of any precise summarization." Those of the second category are more easily dealt with. "Man's retention of astonishingly primitive features is a condition that has not attracted the attention that it deserves. . . . In the base of the human skull, and upon the sides of the brain case, the bones articulate in an order which is that characteristic of the primitive mammal. In these regions the human skull shows a condition exactly like that of the lemurs. But all the monkeys and anthropoid apes (with one exception) have lost this primitive arrangement and follow an utterly different plan. No monkey or anthropoid ape approaches near to man in the primitive simplicity of the nasal bones. The structure of the back wall of the orbit, the metopic suture, the form of the jugal

¹ This subject has been more fully treated in the author's "Arboreal Man," London, 1916.

bone, the condition of the internal pterygoid plate, the teeth, etc., all tell the same story—that the human skull is built upon remarkably primitive mammalian lines which have been departed from in some degree by all monkeys and apes. As for muscles, man is wonderfully distinguished by the retention of primitive features lost in the rest of the Primates.” The pectoralis minor, for instance, is attached to the coracoid, while in apes and monkeys it has moved downward toward or to the humerus. “The human tongue is not unlike that of the chimpanzee, but no monkey can show nearly so primitive a mammalian tongue as that typical of man. The human vermiform appendix, although usually regarded as a particularly degenerated rudiment is strangely like that of such simple creatures as some of the pouched animals of Australia, and the very different structure found in the monkeys is most likely a specialization from a primitive condition which is retained in man. The great arteries which arise from the arch of the aorta are of the same number and kind, and are arranged in the same order in man and in such a lowly animal as . . . *Ornithorhynchus*. In the monkeys and anthropoid apes this arrangement is departed from.” Turning to the third category special attention is directed to such features as the absence in man of the premaxilla as a complete bony element though this bone is fully developed in the skull of all the monkeys and apes, the presence in the human leg of the peroneus tertius muscle, also an exclusively human peculiarity, and the structure of the human foot. “The human foot is unique in nature; no other animal has a foot with digits and muscles arranged upon the same plan. . . . Man’s big toe has become dominant, his little toe is becoming a rudiment. In all monkeys and apes the toes are arranged as the fingers, and the third toe like the third finger is the longest.” Each of these strictly human characters originates, at a very early embryonic stage, directly, that is without passing through a stage recalling the condition found in monkeys and apes. After reviewing this evidence “we are left with the unavoidable impression that the search for his [man’s] ancestors must be pushed a very long way back. It is difficult to imagine how a being, whose body is replete with features of basal mammalian simplicity, can have sprung from any of those animals in which so much of this simplicity has been lost. It becomes impossible to picture man as being descended from any form at all like the recent monkeys, or anthropoid apes, or from their fossil representatives. . . . He must have started an independent line of his own, long before the anthropoid apes and the monkeys

developed those specializations which shaped their definite evolutionary destinies." Some idea of the stock from which the human line took its origin may be gained from the characters of *Tarsius*, an animal usually included among the lemurs, but here, as by Wortman in 1903, placed definitely with the monkeys and elevated to the rank of a special group. "He is a most highly specialized little creature along his own curious lines and yet he retains with man a host of those astonishingly primitive features that place this odd couple at the base of the Primate stem. He lingers today, a specialized primitive Primate, nearer akin to man than any other animal known to the zoölogist." But even with the truth of this relationship admitted it remains impossible to formulate a definite conception of the original stock, for "no fossil has so far been discovered which throws any real light upon the characters of such a creature." It can only be said that: "The pro-human member of the human stock would probably be a small animal, and we would not venture on a nearer guess than that which anyone is free to make as to the identity of an animal intermediate between a *Tarsius*-like form and man."

COMPARISON OF THE TWO MAIN HYPOTHESES

Such are the two hypotheses as set forth by Doctor Gregory and Professor Wood-Jones. In the following tabular statement I have tried to contrast and emphasize their differences.

SIMIAN HYPOTHESIS

The evidence of embryology and comparative anatomy shows that the *Hominidæ* have been derived from ancestors which were in fact heavy jawed, stout limbed, tailless and semi-erect anthropoid Catarrhinæ.

Man's nearest existing relatives are the chimpanzee and gorilla

TARSIAN HYPOTHESIS

The evidence of embryology and comparative anatomy shows that the *Hominidæ* could not have been derived from ancestors which had first become specialized as heavy jawed, stout limbed, tailless and semi-erect anthropoid Catarrhinæ; on the contrary it shows that the members of the ancestral stock were small animals without anthropoid catarrhine specializations.

Man's nearest existing relative is *Tarsius*.

(Gregory) or the gibbons (Pilgrim, Rec. Geol. Surv. India, 1915, XLV, pl. 4.)

The distinctively human line originated at about the middle (Gregory) or end (Smith Woodward, Nature, November 6, 1919, CIV, 212) of the Tertiary period, the hominid branch diverging from the anthropoid stem after the separation of the gibbons (Gregory), or directly from the early gibbon stock (Pilgrim), or from great ground apes with a truly overgrown brain (Smith Woodward).

The origin of the human line was coincident with a profound and relatively abrupt change of life habits.

Since its origin the human stock has developed more rapidly than the anthropoids from which the human stock sprung; but it is not unlikely that a profound and relatively abrupt change of life habits may sometimes cause evolution to proceed with unusual rapidity.

The ancestral chimpanzee-gorilla-man stock appears to be represented by the Upper Miocene genera *Sivapithecus* and *Dryopithecus*.

The evidence of embryology and comparative anatomy shows that man has been derived from a definitely anthropoid ancestry. In support of this view reliance is placed chiefly on the many

The distinctively human line originated not later than the beginning of the Tertiary period, without ever having been directly connected with the anthropoid stem.

The origin of the human line was not coincident with any profound and relatively abrupt change of life habits.

There is no reason to suppose that the evolution of man has been more rapid than that of other primates.

The ancestral human stock is not represented by any extinct form yet discovered.

The evidence of embryology and comparative anatomy shows that man has not been derived from a definitely anthropoid ancestry. In support of this view reliance is placed chiefly on the

features of general and special resemblance between men and great apes. (In a letter dated April 29, 1919, Dr. Gregory writes: "In my brief paper, 'Studies,' part 2, I did not think it necessary to go into details except in certain directions, but I had in mind not only many observations of my own and of others on the skull, dentition, skeleton; but also the great mass of special anatomical similarities in the integument, brain, reproductive organs, viscera, muscles, larynx, parotid and other glands, fundus oculi, diaphragm, auditory ossicles, etc., recorded in literature, not to mention blood precipitin tests, psychologic reactions, etc.")

peculiarities of human structure mentioned below:

(a) In the base of the skull and on the side of the braincase the bones show the primitive interrelationships found in lemurs but lost in monkeys and all but one of the great apes.

(b) Nasal bones more primitive than in monkeys and apes.

(c) Primitive characters, lost or modified in the monkeys and apes, are found in the back wall of the orbit, the metopic suture, the jugal, the internal pterygoid plate, and the teeth.

(d) The pectoralis minor muscle retains its primitive attachment to the coracoid; this attachment has been modified in monkeys and apes.

(e) The great arteries which

The human foot could be easily made from a gorilloid type of foot by relatively slight changes. It seems amazing that the relatively small morphological difference between the limbs of *Homo* and those of *Gorilla* should frighten some authors into constructing purely hypothetical phylogenies in which these two related genera are placed far apart.

arise from the arch of the aorta are of the same number and kind, and are arranged in the same order in man and *Ornithorhynchus*. In monkeys and anthropoid apes this arrangement is departed from.

(f) The human foot is unique in nature; no other animal has a foot with digits and muscles arranged on the same plan. Man's big toe has become dominant, his little toe is becoming a rudiment. In all monkeys and apes the toes are arranged as the fingers and the third toe like the third finger is the longest.

(g) The premaxilla does not exist as a complete bony element at any stage in the development of the skull, while in monkeys and apes it is a distinct and complete bone until after birth.

(h) The human peculiarities of the foot and premaxilla originate in the embryo without passing through a stage in which the structure resembles the conditions found in other primates; this is also true of the peroneus tertius, a muscle peculiar to the human leg and foot. Very great antiquity of the human stock is thus indicated.

OBJECTIONS TO THE TARSIAN HYPOTHESIS

Each hypothesis as it now stands is open to serious objections. It is not now necessary to take up all of these objections in detail; I wish merely to direct attention to some of the more conspicuous. The peculiarities of human structure on which the Tarsian hypothesis

mainly rests do not all appear to lead necessarily to the conclusion that the human ancestral branch goes back to a point far behind that at which the anthropoid branch became distinct from the generalized primate stem. It is difficult, for instance, to appreciate the characters of the human nasal bones which make them more primitive than those of monkeys and apes. In another connection¹ I have shown that the human nasals seem to be modified as one of the mechanical consequences of the maxillary retraction which is peculiar to man. The nasals of monkeys and apes usually retain a form which is more like that found in the majority of mammals; when specialization occurs (as in *Presbytis*, *Simias*, *Rhinopithecus*, *Nasalis*) it is not in the same direction as the human type. Equally difficult to understand is the supposed primitiveness of the metopic suture in man. This suture is frequently indicated in the skulls of monkeys and apes, its development not differing appreciably from that commonly seen in human subjects. Wortman's recent account² of the jugal bone in the primates does not indicate that the structure found in man is especially primitive. Human teeth are obviously more specialized than those of some of the great apes, notably the gorilla. It is true that the arrangement of the main arteries arising from the arch of the aorta differs in man from that which is found in the lemurs, monkeys and one of the great apes, the orang. But the human condition is identical with that which occurs in the chimpanzee and gorilla. This fact removes the significance that has been attributed to the resemblance which exists in this respect between man and such a "lowly" mammal as the duck-bill.

Particularly inconclusive are the arguments based on the insertion of the pectoralis minor muscle and the excessively reduced condition of the human premaxillary bone.

Of the muscle Professor Wood-Jones says: "... we find it in man attached to the fore-limb at the coracoid process of the shoulder-girdle. In the anthropoid apes it is attached in part to the process,



FIG. 1. Arrangement of large arteries arising from arch of aorta: *a*, lemurs, monkeys, gibbons and orang; *b*, chimpanzee, gorilla, man and duckbill. *c*, *c'*, carotids. After Owen.

¹ Smithsonian Miscellaneous Coll., November 24, 1915, LXV, No. 12, p. 16.

² Pp. 18-19 of his paper: "On Some Hitherto Unrecognized Reptilian Characters in the Skull of the Insectivora and other Mammals, *Proc. U. S. Nat. Mus.*, LVII, 1-52, April 5, 1920.

and in part to a ligament which passes downward to the humerus. In the monkeys it is still further down the ligament, and is attached also to the humerus. In many quadrupedal mammals it is attached altogether to the humerus. . . . The coracoid process is the primitive attachment of this muscle, and man and some other exceedingly primitive animals retain this type of insertion. But by stages this primitive arrangement is lost in monkeys and apes, and is most widely departed from in the so-called lower quadrupedal mammals." Professor George S. Huntington, however, in dealing with the same subject comes to a totally different conclusion.¹ He writes as follows: "With a few exceptions, depending on individual variation, the pectoralis minor and pectoralis abdominalis of the Prosimiæ and of both the catarrhine and platyrrhine groups of the lower monkeys insert into the capsule of the shoulder joint and through its fibers into the radial tuberosity and the adjacent lateral surface of the shaft of the humerus, under cover of the pectoralis major. . . . In the anthropoid apes and in man the insertion of the pectoralis minor migrates cephalo-mesad, leaving its primitive association with the pectoralis abdominalis and gaining a secondary point of insertion into the medial border and part of the upper surface of the coracoid process, the distal portion of its original tendon remaining as the coraco-humeral ligament between the coracoid process and the humeral capsule. As a reversional atavial variant in man, and more frequently in the anthropomorphs, especially the chimpanzee, the muscle forms a rounded tendon of insertion which, in part or as a whole, passes outward above the coracoid and under cover of the coraco-acromial ligament to reach the radial tuberosity of the humerus through fusion with the shoulder capsule, at times partly united with the supraspinatus tendon."²

Of the premaxilla Professor Wood Jones remarks: "One . . . point concerns the architecture of the bony upper jaw, for the bone which carries the incisor teeth (premaxilla) has ceased to exist as a separate entity on the human face. In all the monkeys and apes, as in all other mammals, this premaxillary element is mapped out on the face by suture lines marking its junction with the maxillary bones. In man alone has an alteration in the method of growth of this region

¹ "Modern Problems of Evolution, Variation and Inheritance in the Anatomical Part of the Medical Curriculum, *Anat. Record*, June 20, 1918, XIV, 397-398.

² Keith writes: "The secondary attachment of the pectoralis minor to the coracoid process, a constant insertion in man, is the rule in gorillas and the exception in chimpanzees; it occurred in 8 out of 9 gorillas and 7 out of 18 chimpanzees" (*Proc. Zool. Soc. London*, 1899, 307).

led to a loss of the individuality of the premaxillary element. This is a human specific character. From all orthodox teaching we should therefore expect it to be very late in its appearance in the human embryo; we should hardly look for it earlier than the fifth month. As a matter of fact this character is established as soon as ever the future bones of the human face are represented as cartilaginous nuclei. It has become a character of the human embryo at a stage when development has proceeded so little way that the future being is no longer than ten times the diameter of an ordinary pin's head. Such a finding, in the development of any animal, forces the conclusion that a distinctive feature, so early acquired in embryology, was early acquired in history and that the species must be very old indeed. It therefore seems possible that not only is man an excessively primitive animal, which originated right at the base of the primate stem, but he probably also acquired his specific characters in an extremely remote past." Boule, however, positively states that the human premaxillary bone is not only present but of simian character in human embryos at the middle of the third month.¹ Conclusions resting on evidence whose nature and meaning are so obscure as to permit the simultaneous existence of such opinions can not be regarded as final.

OBJECTIONS TO THE SIMIAN HYPOTHESIS

The Simian hypothesis contains elements of weakness which make it almost equally difficult to accept in its present form. Many of these have been discussed, notably by Professor Wood-Jones in "The Problem of Man's Ancestry," and by Professor Boule in the last chapter of "*L'Homme fossile de la Chapelle-aux-Saints*." Two of them appear to have been generally overlooked, or at least to have received less attention than they deserve: the manner in which anthropoid apes use their feet when walking or standing on flat surfaces, and the improbability that the point of departure of the definitely human line of descent was determined by any abrupt change in environment or in habits.

A STUDY OF THE FEET OF GREAT APES IN LIFE

It may readily be admitted that the morphological differences between the feet of man and the feet of the anthropoids are not very great; of themselves they are probably not enough to "justify the construction of hypothetical phylogenies" in which man is widely

¹ *L'Homme fossile de la Chapelle-aux-Saints*, 1911, 250.

removed from the great apes. But this view of the subject appears to concern itself too exclusively with mere peculiarities of form. It fails to take account of the living animals and the mechanical difficulty of initiating in them the series of modifications that would be required to produce the relatively slight changes needed to bridge the gap between the two types of feet. Doctor Gregory writes:¹ "in order to transform a gorilla-like foot into a human foot it is chiefly necessary (a) to increase the length of the hallux, (b) to adduct it, and rotate it on its own axis so that its plantar surface shall be applied to the ground instead of facing toward the other digits. (c) Next it would be necessary to shorten still further the phalanges and (d) to narrow the whole foot, that is to make all the digits parallel instead of divergent. (e) The tuber calcis and cuboid must be enlarged and (f) the whole foot must be "pronated" or made to face downward rather than inward. As a result (g), the trochlea of the astragalus is made more symmetrical, deeper on the tibial malleolar facet, (h) the head of the astragalus is widened. Those who lose sight of the fundamental principle of the change of function . . . will hardly realize that by the foregoing relatively slight morphological changes a gorilloid type of foot could be easily made over for service on the ground. . . . I hold that as the ancestral *Hominidæ* gave up arboreal . . . habits and assumed the life of hunters upon the ground . . . the hallux was lengthened, rotated about its own axis and brought into alignment with the other digits. . . ." He offers no suggestion as to the manner in which an arboreal foot like that of a great ape could be so used on a flat surface as to stimulate or even to permit the process of carrying out such an evolution. The same is true of a similar exposition published by R. Anthony in 1912² which does not differ very essentially from that of Doctor Gregory except in the stress which it lays on the importance of the development of the human instep arch. Neither of these writers, nor, so far as I have been able to ascertain, any one of those who have dealt with the subject, alludes to the manner in which the great apes use their feet when walking or standing on flat surfaces. Of the living great apes the orang has a foot so extremely modified for arboreal life that it requires no special consideration here. Apparently the animal does not leave the trees so freely as the gorilla

¹ *Bull. Amer. Mus. Nat. Hist.*, 1916, XXXV, 332, 336.

² Section entitled "Le problème de l'origine de l'homme," in his paper "Contribution à l'étude morphologique générale des caractères d'adaptation à la vie arboricole chez les vertébrés." *Ann. Sci. Nat., Zoöl.*, Ser. 9, XV, 101-342.

and chimpanzee, both of which spend much of their time on the ground.

A partial idea of the action of a gorilloid foot on a flat surface may be gained from the photographs published in plates 1 and 2. One of these photographs (Pl. 1, Fig. 2) represents a young gorilla and was kindly placed at my disposal by Dr. William T. Hornaday.¹ Another, showing a chimpanzee standing erect (Pl. 2), was obtained from the firm of Underwood and Underwood. The rest Mr. J. W. Gidley and I took during two walks through the National Zoölogical Park with the chimpanzee "Sokko," an animal seven years old, received from French Congo in 1915, and now weighing 100 pounds. Fig. 1 (Pl. 1) shows the foot in resting position. The knee is held almost straight and the tarsus and heel sustain the weight transmitted directly downward from the pelvis. The phalanges and the metatarsal portion of the foot, entirely in front of the region of support, lie on the ground in a peculiar sprawling inefficient attitude. The hallux is separated from the other digits as if to grasp the earth in as nearly as possible the same manner that it would grasp a large tree trunk. It is directed somewhat inward under the body. Digits two to five are held close together and parallel with each other; their general direction is usually a little outward with a forward curve strong enough to bring the tips nearly in line with the body. The hallux is the only one of the digits that is pressed flat or almost flat against the ground; the others are turned so as to rest obviously on their outer sides. The exact position of the toes varies according to the position in which the foot comes to rest, but not sufficiently to obscure the essential features just described except when the clubbed attitude of the foot is assumed. When this is done all the digits are flexed and the foot is turned so as to rest on its outer side. The clubbed position is indistinctly shown in the left foot of Fig. 3 (Pl. 1). It is essentially the same as the grasping attitude (see left foot in plate 2). "Sokko" usually held his left foot in this manner, though

¹ It is unfortunate that photographs of a gorilla's foot in action could not be obtained, but they would probably have not shown anything essentially different from the chimpanzee. Professor Keith says that "the body of the gorilla is more adapted for the human manner of progression than that of the chimpanzee." He adds, however, that: "As a grasping organ, made up of two limbs, a hallucial limb on the one side and a digital limb on the other, the foot of the gorilla does not differ materially from that of the chimpanzee. The proportional length of these limbs to each other and to the lower extremity, as seen in the skeleton, is alike in both. The muscles that act upon them, except in minor details, are almost alike" (*Proc. Zool. Soc. London*, 1899, 304).

he not infrequently changed it to the normal attitude. He was not seen to club the right foot. How far this variation is the use of the digits is a normal feature in chimpanzees or how far it is an individual habit I am unable to say. I have not noticed it in photographs of other animals, but Dr. W. L. Abbott writes me that one of the chimpanzees in the Philadelphia Zoölogical Gardens uses both feet in this way, while another has never been seen to do so. During the forward step (Pl. 1, Figs. 3, 4, 5) the knee is bent and the heel is raised. When the foot is in the normal attitude the weight of the body is transferred almost at once to the tips of the digits. No phase could be observed which corresponded to the rising on the metatarsals which forms such a conspicuous feature of the human tread.¹ The great toe is now thrown strongly inward, but the other toes, closely pressed against each other, form a continuation of the outwardly directed main axis of the foot (Pl. 1, Fig. 5), their tips turning slightly inward as they relax after leaving the ground (Pl. 1, Fig. 5). The weaker digits collectively act as one tine of a two-pronged fork whose other branch is the powerful hallux. The foot therefore normally functions as a tripod, receiving the body weight on the posterior point of support, and pushing the animal forward by means of the two widely separated anterior extremities (Pl. 1, Fig. 4). The great size of the hallux makes it appear to be about equal in strength and in functional importance to the combined four smaller digits. No photographs of "Sokko" in the upright attitude were obtained, but the photograph of another animal reproduced in plate 1 shows the position assumed by the foot when a chimpanzee stands erect.

It is obvious that the chimpanzee's foot is ill-adapted to progression on a flat surface. The animal's entire action while walking, though at first vigorous, gives the impression of something forced and unnatural (Pl. 1, Fig. 4 especially); the parts of the machine appear to lack coördination, thus presenting a striking contrast to the perfect adjustment and poise which they show during tree climbing. Fatigue ensues with noticeable rapidity. It is difficult to believe that an animal with this type of foot would voluntarily and completely abandon arboreal habits. If forced to become terrestrial by some of the calamities which have been suggested as responsible for the origin of the human line of development it is almost equally difficult to believe that

¹ Cass ("Th. doct. méd., Lyon, 1900," cited by Anthony, *Ann. Sci. Nat.*, 1912, XV, 289) compares the human foot to a tripod whose points of support are the heel and the heads of the first and fifth metatarsals.

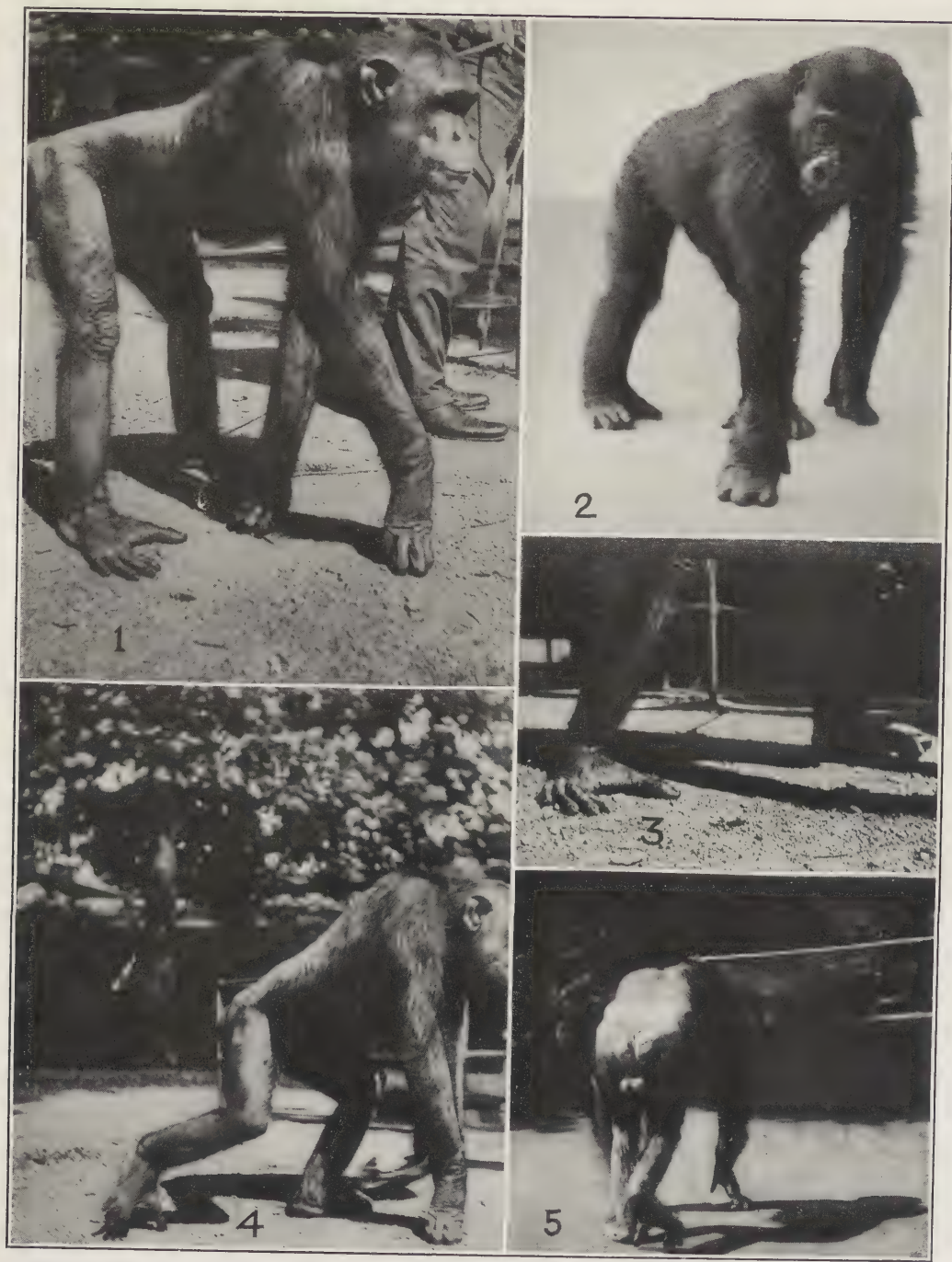


PLATE 1.

FIGS. 1, 3, 4, 5. Chimpanzee from French Congo, now living in National Zoölogical Park, Washington. Photographs taken with the special object of showing the manner in which the hind foot is used on the ground. The resting position is shown in Fig. 1; beginning of forward step in Fig. 3; later stages of forward step in Figs. 4 and 5. The clubbed attitude may be imperfectly seen in the left foot of Fig. 3.

FIG. 2. Young gorilla. Resting position. Photograph presented by the New York Zoölogical Society through Dr. Wm. T. Hornaday.



PLATE 2.

Chimpanzee standing erect. Photograph obtained from Underwood and Underwood.

the creature could survive. But in either event racial existence would largely depend on successful modification of the foot.

Instances are not lacking in which the feet of mammals can be traced through long evolutionary series. It is probably never true, however, that the structure finally reached is not potentially present both morphologically and physiologically in the more primitive members of such a series. The third toe which alone survives in the foot of a horse was the strongest and most-used digit in that of the pentadactyl ancestors; the fourth toe which is the only functional digit in the foot of the marsupial *Chaeropus* occupied a similarly dominant position in the special form of five-toed foot which gave rise to the reduced modern structure. If we seek such traces of the human foot in that of the chimpanzee or gorilla we at once meet with difficulties. In the human foot the digits lie parallel with each other and all act in a manner which is essentially alike; that is, the hallux, together with the other digits, applies its planter surface naturally to the ground when projecting directly forward, and no considerable spreading of its metatarsal inward away from the second is possible, as the distal ends of all the metatarsals are linked together by the transverse metatarsal ligament. In the gorilloid type there is not only no such similarity of position and function but the successful use of the foot on the ground seems to depend on the exact opposite: on the freedom of the first metatarsal from the others and the resulting functional contrast between the independent hallux and the partly joined smaller toes, a fact which is more obvious in the living moving animal than in the photographs. This functional contrast is moreover emphasized when an attitude approaching the human upright position is assumed.

NOTES ON THE ANATOMY, EMBRYOLOGY AND PALEONTOLOGY OF THE HALLUX

Some of the reasons for these peculiarities of a gorilloid foot may be understood when the skeleton, especially a ligamentous preparation softened to allow free movement of the bones, is compared with the photographs of the living animals, and with skeletons of human feet. It then becomes evident that the manner in which the chimpanzee and gorilla use the hallux depends on the freedom of the first metatarsal and on the specialized characters of the joint between the metatarsal and the internal cuneiform. This joint is so constructed that the metatarsal and with it the entire hallux is forced to lie on its inner (tibial) side when the great toe is brought forward approximately in

line with the other digits. The plantar surface is then mechanically turned toward the weaker toes instead of toward the ground, an arrangement perfectly adapted to the use of the foot in climbing but not in walking. When the hallux, however, is gradually drawn away from the other digits its plantar surface becomes more and more turned downward. The human thumb, when the hand is applied to a flat surface too large to grasp, may be seen to act in much the same way. The maximum of this favorable condition is reached when the hallux is held nearly at right angles to the foot, a fact which probably determines the attitude when the animal is standing upright (Pl. 2). In the human hallux the lateral motion, owing to the restraining action of the transverse metatarsal ligament, is very slight. It is not accompanied by an automatic change in the position of the plantar surface.

The structural features which produce these differences in the action of the hallux in the two types of foot appear to be principally the following. In man (Fig. 3 *b*) the concave articular surface on the base of the metatarsal is essentially an impression of the convex anterior surface of the cuneiform. The two surfaces are of about equal size and are gently curved both vertically and laterally. That on the cuneiform is limited to the anterior aspect of the bone, where it lies in a general way parallel with the surface by which the cuneiform articulates upon the navicular. In the chimpanzee and gorilla, however, the articular surface extends over to the inner (tibial) aspect of the cuneiform (Fig. 3 *c*). It is strongly convex laterally and nearly straight vertically, thus giving rise to a subcylindrical, turret-like structure which projects obliquely inward from the general mass of the bone. The turret in the chimpanzee is distinctly wider below than above; in the gorilla it is nearly cylindrical. In both animals its main axis slopes obviously backward and under the foot. The articular area on the metatarsal does not bear the close likeness to the corresponding surface on the cuneiform which is seen in the human foot. Its area is less than that on the cuneiform, and its lower portion is distinctly wider (Fig. 2, *c, d*) and shallower than its upper portion. The pronation of the hallux as it swings away from the second digit appears to be primarily the result of the angle at which the articular turret on the cuneiform is set, and secondarily the result of the wider range of lateral motion allowed by the broader, shallower lower part of the joint as compared with the narrower, deeper upper portion. The downward turning is also increased by the action of a ridge

which is developed along the upper third of the inner (radial) articular margin on the metatarsal. This ridge soon comes to the edge of the cuneiform articular surface and checks the lateral motion above while allowing it to continue below, thus imparting a downward rotation to the entire digit. The turning of the plantar surface toward the other digits as the hallux is drawn forward, is chiefly dependent on the reversal of the processes just described. It is made more effective, however, by the relationship which the joint's axis of lateral motion bears to the sagittal plane of the metatarsal. In both the human hallux, and that of the apes the position of the axis is nearly vertical. The sagittal plane of the metatarsal in man is tilted slightly toward the inner (tibial) side of the foot so that it crosses the axis of rotation at an angle of about 30 degrees, a position not very different from that of the metatarsals of the other digits, and essentially in accord with the lateral arching of the anterior series of tarsal bones (Fig. 2 *a*). A similar condition may be seen in the hallux of the black bear (Fig.

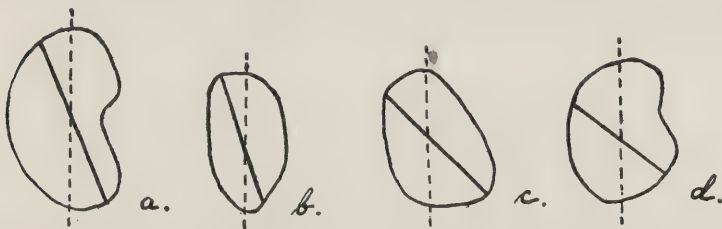


FIG. 2. Outline of articular surface at base of metatarsal of right hallux of a man (*a*), a black bear (*b*), a gorilla (*c*) and a chimpanzee (*d*). The dotted vertical line indicates the position of the axis of lateral rotation on the cuneiform. The heavy line shows the sagittal plane of the metatarsal.

2 *b*). In the gorilla (Fig. 2 *c*) and chimpanzee (Fig. 2 *d*) the tilting of the sagittal plane is carried so much further that the angle formed by the plane and the axis becomes as great as 50 degrees. This causes the metatarsal to lie far over on its tibial side in marked contrast with the position of the metatarsals of the other digits. There is no twisting of the shaft of the bone; the entire metatarsal is rotated, leaving the proximal articular surface with its axis of lateral motion essentially vertical, as might be done with a piece of soft clay pressed against the turret of the cuneiform and then turned inward.

Should a great toe constructed in the manner that we have just seen be thrown forward to a position in any way nearly approaching that assumed by the human hallux and a step then be attempted it is

probable that the animal thus experimenting would suffer acute pain and certain that it would lose much of the power of the foot. The flexor and abductor muscles of the digits exert their force chiefly through the plantar surface, and this surface would be turned away from the ground in the strongest toe of all. The serious impairment of efficiency under such conditions is easily demonstrated by leaning on the hands pressed flat against the top of a table. The support to the body afforded by the hands is much greater when the thumbs are widely separated from the other fingers so that the muscles can act to good advantage than when they are held forward so that the chief muscular force of the thumbs cannot be brought into play.

As I have already said and as most observers must have noticed, the gait of a great ape on the ground is not an easy one. Modifications in the structure of the foot are so evidently needed to fit it for permanent terrestrial use that they would be expected to occur in case any such animal should finally abandon the trees. The question of what form these modifications would be most likely to take does not now concern us; but to have them follow a course which would lead to the human type of foot would necessitate a process which contains two elements that make its accomplishment appear to be contrary to reasonable probability: (a) the hallux in order to be able to apply its power to the ground in the human manner would have to change the character of its basal joint, to remodel the cuneiform bone which supports it, and to bind the distal extremity of its metatarsal to the metatarsal of the second digit by means of the transverse metatarsal ligament, a series of changes which would be so complicated and so indirect as compared with the simple throwing of the great toe inward until the muscular power was naturally applied to the supporting surface that its carrying out in living animals could scarcely be expected; (b) the great apes whose mode of walking is known have adopted the simpler alternative by bringing the hallux to its position of greatest efficiency on the basis of its existing joints, ligaments and muscles. Continued terrestrial use of the hallux in this strictly simian manner could not by any known principle be expected to lead over to the mechanical antithesis presented by the action of the great toe in man. The evolution of some structure very unlike that which characterizes the human foot is therefore indicated as the result of a change to permanent life on the ground by an animal which had first become adapted to a primarily arboreal existence in the particular manner that would be necessary to permit it to be referred to the group of anthropoid apes.

Not only is the improbability that the human foot has been derived from a gorilloid type of structure shown by both anatomy and physiology but the same conclusion is pointed to by the evidence of embryology. Professor Leboucq has studied the early development of the great toe's basal joint in human embryos ranging from 20 mm. to 40 mm. in length.¹ His diagram of the elements of the tarsus and metatarsus at two months (Fig. 3 a) shows that the joint between the inner cuneiform and the metatarsal of the hallux at this early stage lacks gorilloid modification. The peculiarities of the embryo as compared with those of the adult (Fig. 3 b) are chiefly that the tibial margin of the cuneiform is relatively short and the articular facet therefore slopes obliquely forward so that the hallux is made to diverge inward away from the other digits. As development progresses the tibial side of the cuneiform grows more rapidly than the fibular side; the articular surface is thus brought to the position which it occupies in the adult, a result fully attained in embryos 40 mm. long. While there is a definite change, as development advances, in the facet's

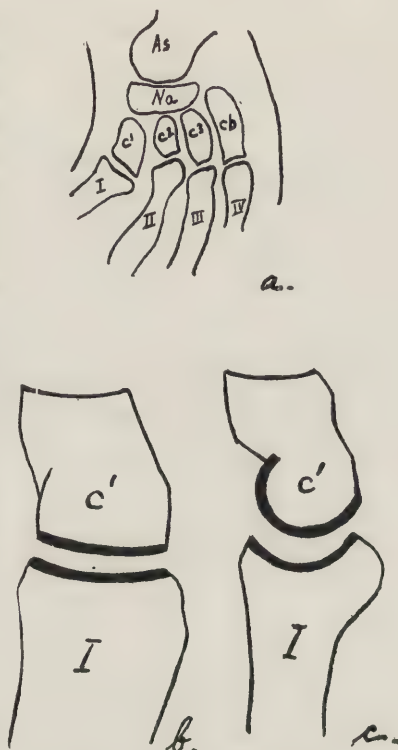


FIG. 3, a, Horizontal section of foot of a human embryo in the second month (length 21 mm. length of foot 2.3 mm.). Fibular side of foot not included in the section. c', internal cuneiform, I, II, III, IV, metatarsals. After Leboucq.

b. Diagrammatic outline of optical cross section in same region of adult human internal cuneiform (c') and first metatarsal (I). The heavy lines indicate the articular surfaces.

c. Same as b, adult gorilla.

¹ "Le développement du premier métatarsien et de son articulation tarsienne chez l'homme," *Arch. de Biologie*, June, 1882, III, 336-344.

See also Figs. 5-15 of the plate (VIII) published by Ruge, "Entwicklungsvorgänge an der Muskulatur des menschlichen Fusses," *Morphol. Jahrbuch*, 1878, IV, Suppl., 117-152.

Aeby (Beiträge zur Osteologie des Gorilla. *Morphol. Jahrbuch*, 1878, IV, 288-313) has observed that the characters of the basal joint of the human hallux are identical in adult and young.

position there is no corresponding change in its curvature. The curvature is at all stages essentially as in the human adult; no true approach to the structure characteristic of the apes (Fig. 3 c) is visible. The course of individual development in the embryo appears to be that which a divergent hallux without prehensile specialization would pass through in assuming the human structure. Haeckel's law is not now accepted in the same literal sense that was once attributed to it; but the fact that the basal joint of the human hallux appears to be free from gorilloid taint at every stage of its development is one whose possible phylogenetic significance cannot be ignored.

The freedom of lateral motion of the hallux which is normal in children and often developed to a high degree in adults, especially among bare-footed peoples, is usually regarded as a character reminiscent of simian ancestry. Professor Leboucq shows that it has no such significance and that it does not indicate anything more than loose-jointedness, a condition which is always present during infancy and which may be retained or acquired in later years. He does not allude, however, to the even more important fact, easily observed in children, and mainly resulting from the action of the transverse metatarsal ligament, that the principal motion involves the phalanges only, and not, as in the apes, the entire digit to the base of the metatarsal. The joint between the first phalanx and the distal end of the metatarsal may occasionally permit a slight but evident turning of the plantar surface of the hallux toward the second digit. The ability to rotate the end of the great toe in this manner is probably subject to much individual variation. I have seen it well developed in a white child four years old, while in his brother at the same age it was absent. Detailed observations on the movability of the hallux in many children and in bare-footed adults would be of much interest. How completely the divergence of the great toe in man differs from that characteristic of the apes is well shown by the figures which Volkov published in 1904,¹ particularly one representing the skeleton of the foot of a negrito. The peculiar condition is obviously a variation of the human type of structure.

Among the extinct higher primates the hallux is unknown except in some of the forms of *Homo*. The Pleistocene men whose feet have been described lacked the extreme specialization for a strictly upright gait which is attained by the foot in living members of the genus. Some writers have interpreted this lesser degree of adaptation

¹ *Bull. et Mém. Soc. Anthropol. Paris*, 1904, Ser. 5, V, 272.

as indicating the presence of a condition intermediate between that of modern man and that of the anthropoids. Boule, however, has pointed out that this condition is morphological and not necessarily geneological, while Gregory recognizes that "truly intermediate stages between the human and anthropoid types of foot" have not yet been discovered. The entirely human character of the entocuneiform and the metatarsal of the great toe in these races of man is evident on comparison of the published figures with the corresponding bones of anthropoids.¹ It is said by Anthony² that Boule regards the joint between the metatarsal and the first phalanx in *Homo neanderthalensis* as having a form which would appear to indicate the opposability of the hallux. Traces of such a *phalangeal* type of opposability, differing radically from the metatarsal type seen in the great apes, may, as I have shown above, be occasionally seen in young children. I am unable, however, to find any allusion to it in the paper cited.³

THE SUPPOSED CHANGES OF FUNCTION

That a change of habits and function in a primate already specialized for arboreal existence after the manner of the great apes marks the beginning of the recognizably human line of descent is very generally believed. Doctor Gregory gives expression to this idea when he alludes to a period when the ancestral *Hominidæ* abandoned arboreal, frugivorous habits and assumed the life of hunters on the ground, a change so profound that it might actually have caused the subsequent evolution of the stock to proceed with unwonted rapidity. Various reasons have been suggested to account for this supposed change; they are so numerous that I shall not attempt to review them in detail. Doctor Houzé,⁴ for instance, thinks that it could not have taken place except through force of necessity. Alteration in climatic conditions might have caused the dying out of the forests in which the animals lived; or the forests might have been destroyed suddenly by fire or by volcanic eruptions. It is difficult, however, to find instances in which an alteration of climate sufficiently great to cause

¹ See especially the plate published by Testut, *Bull. Soc. Anthropol. Lyon*, 1886, VIII, pl. 10.

² *Ann. Sci. Nat.*, Paris, 1912, Ser. 9, XV, 294.

³ *L'Anthropologie*, 1909, XX, 257-271. On p. 271 the author expresses his regret that the metatarsal from La Chapelle-aux-Saints is too imperfect to show whether the great toe was opposable or not.

⁴ P. ciii of his article entitled "Le Problème de l'Origine de l'Homme," *Bull. et Mém. Soc. Anthropol. Bruxelles*, 1911, XXX, lxix-cxxiv.

the elimination of forests can be shown to have been followed by the adaptation of the local arboreal mammals to a strictly terrestrial life. Conceivably the ground inhabiting marsupials of Australia, all of which appear to have had arboreal ancestors, might owe their change of habits and structure to some such cause. On this relatively limited land area they would have had less opportunity than on a large continent to escape from the new conditions by migrating. But it is not known that Australia before attaining to its present semi-arid state was ever so completely and densely forested that it could have supported no mammals other than those which were strictly arboreal. Wherever we have anything that approaches adequate knowledge, we find that profound environmental changes are usually accompanied by extinction of the mammal fauna or by removal of the fauna to regions where the original conditions are still to be found. The history of the last glaciation in Europe and in the eastern United States illustrates this well-known fact. Many of the mammals which then occurred in central Europe or in the central United States are now extinct. Others, slightly altered in their characters, have retired northward with the environment suited to their needs. It probably cannot be shown that any of them have remained behind, adopting new habits in conformity with new conditions, and evolving more rapidly than those which escaped from subjection to a change.

While it should doubtless be admitted that the structure of some mammals may have been altered as a response to profound local changes, definite proof that such a process is an important or constant element in modifying the structure of mammals in general can scarcely be said to exist. On the other hand indications may everywhere be observed that another force, much more potent and wide reaching, is ceaselessly at work. This is the process which has been called "local adaptive radiation": the tendency almost invariably shown by different nearly related animals to become adjusted to different parts of their common environment, or in one part of this environment to specialize different parts of the body in ways that are physiologically and mechanically feasible.¹ Among the microtine rodents some burrow

¹ While radiation is principally known from its later or final results the initial stages of the process may be shown by some of the Indian members of the *Rattus rattus* group of house rats described by Hinton (Journ. Bombay Nat. Hist. Soc., December 20, 1918, XXVI, 65-68), by the American grizzly and brown bears (Merriam, North Amer. Fauna. No. 41, February 9, 1918), and by the wall lizards of Europe (Boulenger, Trans. Zool. Soc. London, 1905, XVII, 351, 1912, XX, 204, Dehaut, Contrib. à l'étude de la vie vertébrée insulaire etc., 1920, 1-19).

in the ground, and their skulls assume a characteristic form; other, live an aquatic life, and the nature of their fur, the form of their feets and sometimes that of their tails is distinctly altered; still others live on the surface of the ground and retain a more generalized structure better adapted to a variety of uses; but each type is merely occupying one of the many parts into which the environmental conditions of any north-temperate region are usually divided, and at the same time is specializing some part of the body structure possessed by all the members of the group. Among the squirrels living in a uniformly forested tropical area, one, like *Ratufa*, may feed chiefly on soft fruits, another, like *Reithrosciurus*, may prefer hard shelled nuts; the musculature of the jaws and the structure of the teeth will differ coincidentally with the food habits. Leopards and Cheetahs occur together, but one has retained the form of an ordinary cat and brought it to an extreme degree of efficiency, while the other has developed its running powers and the running machine that can be made from a cat's body. Running and jumping are modes of progression both of which are possible to the majority of mammals; in various unrelated groups some members have developed their aptitude toward the first of these modes, others that toward the second. And this may happen in the absence of visible environmental contrasts. The condition of the hind legs in the rodents of the genera *Zapus* and *Sicista* furnishes a good example. This exploitation of structural possibilities has been carried to an extreme by the primates. Among the South American monkeys *Ateles* has a tail so long, muscular and prehensile that it acts as a fifth arm and hand in climbing; *Cacajao* has the tail so short that it can serve no important mechanical function; the marmosets, unlike all other monkeys, climb by means of claws similar to those of squirrels; *Alouatta* has the molars conspicuously cusped and ridged, while in *Pithecia* the crowns of these teeth are flattened and finely wrinkled; the voice and the vocal organs of *Alouatta* are enormously developed; the eyes of *Aotus* are enlarged in conformity with nocturnal habits. Among the primates of the Old World many evidences of the same tendency may be seen. In the tropical forests of the Malay region, where environmental conditions are remarkably uniform, occur such strikingly contrasted types as *Presbytis*, *Nasalis*, *Hylobates* and *Pongo*, while in those of Africa are found the guenons, the horse-tailed monkeys, the chimpanzees, and the gorillas. Not one of the specializations shown by these various animals has ever been supposed to coincide with a peculiarity of environment that was

not equally at the disposal of all the other primates of the regions in question, and not one of these primates is known to have ever lived under conditions different from those which characterize its present surroundings. Nothing suggests that any one of these special lines of development owes its inception to some change of habits and function which was relatively abrupt.

In view of all these facts and especially in view of the conspicuous versatility shown by the primates in modifying different parts of their common structure without the intervention of known environmental change, there appears to be no sufficient reason for assuming that one member of the group forms an exception to the general rule and that an external change of any kind was either a necessary or a probable factor in the early development of the particular branch of primate evolution which led to man.

THE EXPLOITATION OF OPPORTUNITIES

On the contrary it may not unreasonably be supposed that the human branch like other branches owed its inception to a "radiation" or an "exploitation," a term which would perhaps be more expressive. This separation from the common primate stock seems to have taken place near the point of departure of the line represented by the chimpanzees, the gorillas and their extinct relatives, and at a very remote period when the great toe either retained the simple divergent character which, as Gidley has shown,¹ was probably its original condition in mammals, or at least when it had not gone far in specializing for prehension. The process would have been characterized at the beginning by the adoption of a habit of climbing in which the grasping power of the hands was more used than that of the feet, a manner seemingly as feasible as any other. Coincidentally with this use of the hands the thumb became modified into a perfect grasping organ such as does not exist in the hand of any other known primate, while the great toe was left with no marked trace of the grasping adaptations which it was receiving in the nearly related incipient great apes.

The possibilities offered by terrestrial life have not been exploited by American monkeys, but among the monkeys of the Old World there are numerous forms which live habitually or even entirely on the ground. The macaques and their relatives the Celebean and Barbary apes furnish examples of monkeys which live much on the ground, and in regions where trees are not absent. Some of the baboons live

¹ *Journ. Washington Acad. Sci.*, May 19, 1919, IX, 273-280.

entirely on the ground, or rather among rocks, but this appears to be only in places where there are no forests. The extreme development of the terrestrial tendency is probably shown by the patas monkeys, which occur mostly in parts of Africa where forest and open country are mingled. So completely have these animals learned to depend on running for safety that they cannot ordinarily be driven to climb trees. All of these experiments in terrestrial life appear to be of relatively recent origin and to represent partial abandonment of arboreal specializations. The hallux retains its opposability, but it shows a tendency, as in the terrestrial marsupials, to become reduced.

To return to the early human line. The second phase of the exploitation process was probably the slow assumption of terrestrial habits through such gradual stages as can be seen among the existing monkeys of the Old World. In the foot the spreading but not automatically opposable hallux would have had at least as much muscular power when held parallel with the other digits as when thrown inward, because in either position its plantar surface would have been applied to the ground; when held close against the second toe it would certainly have been least exposed to injury. Through the development of the peroneus tertius muscle the outer side of the foot would be raised and the mechanical stress in walking would be thrown more and more on the great toe. The conditions needed for the development of the human foot would thus have been realized. At the same time the opposability of the thumb would have acted as an obstacle to the development of a good terrestrial fore foot, just as we see that the parallel specialization in the hallux of the great apes appears to stand in the way of producing a serviceable hind foot. The most natural tendency would therefore have been for the animals to continue to use the hands for grasping and the feet for walking as they had previously learned to do among the branches of trees. It is conceivable that this mechanical coincidence of foot and hand in a primate gave the first impetus toward the permanent assumption of the upright position of the body. Whether or not it actually gave this impetus it at least might have furnished an important part of the mechanical and physiological material required for the evolution of man.

SUMMARY AND CONCLUSION

(1) The absence of direct and conclusive paleontological evidence leaves open a wide field for speculation as to the probable course of development followed by the members of that branch of the primates

which has produced man. (2) That the family *Hominidæ* comes from a single ancestral line is sufficiently indicated by the essential uniformity of all known men, living and fossil, in both the specialized and generalized parts of their structure. (3) The hypotheses containing the idea that different races originated from different primate stocks are based on features of secondary importance or on evidence which appears to be insufficient. They may therefore be disregarded. (4) Of the various other hypotheses two seem worthy of special attention: (a) the "Simian hypothesis" according to which the human line branched off, as the result of a profound change of habits and function, in relatively recent geological time from a stock which had first become so definitely simian that it would be recognized as coming within the limits of the family which includes the gorilla and chimpanzee, and (b) the "Tarsian hypothesis" according to which the human line took its origin from *Tarsius*-like animals at a very remote period without a profound change of habits and function, and that throughout its subsequent course it has been distinct from the line of the apes. (5) Both of these hypotheses in their present form are open to serious objection, the "Tarsian hypothesis" mainly because much of the evidence cited in its support is susceptible of other interpretations, and the "Simian hypothesis" mainly because it is based almost exclusively on morphological characters without full regard to the facts which can be derived from the study of living animals. (6) The hypothesis which now appears to account for the greatest number of facts in the simplest manner may be stated as follows:

The distinctively human line branched off from the generalized primate stock at a point near that at which the line leading to the gorilla and chimpanzee originated and at a time when the great toe had not lost its simply divergent character. The inception of this line was not due to a profound and relatively abrupt alteration of habits and function forced on the animals by environmental change, but to a process the evidence of which may be seen everywhere among mammals living under uniform conditions and of which the primates furnish many striking examples. This is the process known as "local adaptive radiation," or the exploitation by different members of a group of the possibilities offered by different elements of their common environment and common structure. The special "exploitation" in this instance consisted in the development of the grasping powers of the hand rather than those of the foot, while among the ancestors

of the great apes the opposite was occurring. Coincidentally with the development of the hand terrestrial habits were gradually adopted, through stages such as may be seen among the living Old World primates. The hind foot was thus brought to the ground without the incumbrance of a hallux specialized for grasping, while the hand was so modified that its use as a fore foot was made difficult. This combination of circumstances supplied the structural and functional elements needed for initiating the series of changes which finally produced the essential characters of the human form.

THE ANTHROPOMETRY OF PORTO RICO

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The following anthropometric observations were taken in connection with the Survey of Porto Rico organized by the New York Academy of Sciences and carried through in part with the assistance of the Government of Porto Rico.

The material studied was obtained by the kind assistance of the Superintendent of Schools of Utuado, Mr. Blanco, who facilitated in every way the measurements of the school children of that town. It was not possible to obtain permission to measure girls. The adults were measured in San Juan and were soldiers of the garrison. Permission to measure these was obtained through the kind assistance of Major Dutcher, U. S. A., who also assisted in the taking and recording of the observations. The measurements of children were taken by myself with the assistance of Dr. J. Alden Mason and Mr. Robert Aitken, who took photographs of the children and made plaster casts of their teeth.

In the following remarks, I give only the average measurements, since the study of the variabilities of the series does not present any particular problem.

The two questions that I desired to investigate were, on the one hand, growth in a tropical climate, on the other hand, that of the similarity of the Porto Rico type and the Spanish type.

There is a certain difficulty in determining the descent of the Porto Ricans. Spanish immigration is still quite considerable as is shown by the fact that among the 618 parents of the 309 children observed, there were 49 born in Spain. The number of brothers and sisters in the series is not large enough to affect this observation appreciably. We have therefore among the parents of the present generation of children, 8 per cent of individuals born in Spain or on the Canary Islands. This includes a few individuals born in Corsica. Unfortunately, my efforts to obtain information in regard to earlier immigration from Spain did not lead to any result, but there is little doubt that the bulk of the population must be considered as of Spanish descent. The question arises in how far Indian blood may survive

in the Island. It is claimed, for instance, that in the mountainous region of the western interior, the Indian type may be observed in the native population. I doubt whether there is an appreciable difference in this respect. It seems, however, not impossible that the amount of Indian blood in the rural districts is more than is ordinarily assumed. Judging from the conditions of early colonization, it seems likely that there must have been a considerable number of half-bloods, descendants of Spaniards and of native women, and through their descendants, particularly through their female descendants, a certain amount of Indian blood may have been preserved in the islands. Assuming, for instance, that a very short time after discovery, the population of Porto Rico should have been one half Spanish and one half Indian, and assuming from that time on an immigration of 10 per cent of Spaniards for each of twelve generations, we should find at the present time still 14 per cent of Indian blood. I do not mean to imply that this corresponds to the actual conditions, but it gives us some impression of the probability of the survival of Indian blood in the island.

Besides this, we have to take into consideration the effect of the importation of negro slaves. Even at the present time, we find locally pure negro colonies, and mulattos are easily distinguished in all parts of the island, particularly, as it would seem, along the highways of communication. In the series of observations of adult soldiers, I have grouped the material into three classes: A I, including those who had one parent born in Spain or on the Canary Islands; A II, those whose parents were born in Porto Rico and who show no undoubted evidence of negro descent; A III, those whose parents were born in Porto Rico and who show undoubted evidence of negro descent. The table of measurements shows that the stature of the three groups is very nearly alike, there being a slight increase from the first group to the third. Finger reach shows the characteristic features of negro finger reach in group III, while group II is intermediate between the first and the third groups. The same is true of the height sitting. The width of the face also shows a distinct increase from group I to group III. All these data make it fairly clear that group II must contain a certain number of negro elements.

Since the stature does not show considerable differences in the three groups, and since the negro elements were few in number, I have not subdivided the observations on children which represent, therefore, the observations made on the population as a whole.

A particular difficulty was developed by the fact that the ages of

the children were not given accurately. The ages stated by the children were compared with the records of birth kept in the municipality which may be taken as fairly accurate, although it seems likely that in some cases a birth was recorded a few months after it actually occurred. Table I shows the total number of children observed for

TABLE I.—TOTAL NUMBER OF CHILDREN AND NUMBER OF THOSE WHOSE AGES WERE VERIFIED.

	Age													
	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Total number of children	4	13	25	21	34	28	30	36	44	26	16	14	11	6
Number of those whose ages were verified	2	6	15	11	21	19	18	26	24	17	8	6	6	5

each age and the number of those whose ages were verified. Table II shows the errors in age among the children whose records were investigated. This will indicate the degree of inaccuracy introduced by

TABLE II.—AGE GROWN BY CHILD MINUS AGE ACCORDING TO OFFICIAL RECORDS.

Difference	Age														Total
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
- 3	-	-	-	-	-	-	-	1	1	-	-	1	-	-	3
- 2	-	-	-	-	1	2	5	1	-	-	-	-	-	1	10
- 1	-	3	2	2	5	4	4	8	10	9	2	3	1	3	56
0	-	2	13	6	12	9	11	11	9	6	5	1	3	1	89
+ 1	2	1	-	3	3	4	-	1	2	1	-	2	-	-	19
+ 2	-	-	-	-	1	1	1	1	1	1	1	-	1	-	7

the inclusion of the unverified cases. On the average, the ages recorded seem to be correct, but the variability of the observation for each year is unduly increased by the inaccuracy of the record.

The observations obtained on children and adults are recorded in Tables III, IV, and V. It must be understood that the observations on soldiers are not strictly comparable with those of school children because all lower statures are excluded, and because there is furthermore a selection according to general state of health of the individual. The stature of the adult is therefore without any doubt too high.

A comparison of the growth curve of Porto Rican children and Mexican and Italian children (Table VI) shows that the Porto Rican children are almost throughout shortest. Since the stature of the

TABLE III

Age	Number of Individuals	Height Standing	Finger Reach	Height Sitting	Height of Acromion	Height of Point of Second Finger	Width of Shoulders	Width of Right Hand over Knuckles	Length of Second Finger	Greatest Length of Ear
6	4	1099	1117	605	902	417	245	55	62	55
7	13	1143	1149	609	898	408	243	58	64	52
8	25	1180	1181	621	934	428	250	58	67	54
9	21	1243	1265	664	1005	462	267	61	70	55
10	34	1276	1262	664	1022	464	271	61	72	55
11	28	1308	1318	681	1055	487	274	63	74	54
12	30	1367	1383	709	1110	516	284	65	76	56
13	36	1384	1428	712	1130	524	290	66	79	57
14	44	1467	1501	752	1195	552	307	71	85	58
15	26	1522	1567	773	1250	574	322	76	89	59
16	16	1580	1643	803	1291	594	335	78	93	61
17	14	1603	1654	819	1308	608	344	78	93	59
18	11	1645	1712	852	1333	607	360	80	95	60
19	6	1620	1677	850	1325	623	361	81	92	59
A I	35	1681	1748	876	1362	623	384	83	95	62
A II	175	1685	1762	870	1373	625	377	84	96	62
A III	57	1687	1773	866	1370	621	388	84	97	60

adult of Porto Rico and the adult of Sicily is approximately the same, it seems likely that this smallness in stature during childhood may be due to a general physiological retardation.

TABLE IV.—RATIO BETWEEN HEIGHT STANDING AND

Age	Number of Individuals	Length of Arm	Finger Reach	Height Sitting	Height of Acromion	Height of Point of Second Finger	Width of Shoulders
6	4	44.1	101.5	55.0	82.0	37.9	22.3
7	13	43.0	100.8	53.4	78.8	35.8	21.3
8	25	42.9	100.0	52.6	79.2	36.3	21.2
9	21	43.7	101.0	53.5	81.0	37.3	21.5
10	34	43.6	99.0	51.9	79.8	36.2	21.2
11	28	43.3	100.8	52.0	80.5	37.2	20.9
12	30	43.3	101.2	51.8	81.0	37.7	20.7
13	36	43.9	103.2	51.6	81.9	38.0	21.0
14	44	43.7	102.3	51.1	81.3	37.6	20.9
15	26	44.4	103.0	50.9	82.2	37.8	21.2
16	16	44.1	104.0	50.8	81.7	37.6	21.2
17	14	43.8	103.2	51.2	81.8	38.0	21.5
18	11	44.0	104.2	51.6	80.8	36.8	21.8
19	6	43.3	103.5	52.5	81.8	38.5	22.3
A I	35	44.0	104.0	52.1	81.1	37.1	22.9
A II	175	44.2	104.6	51.5	81.2	37.0	22.3
A III	57	44.4	105.1	51.2	81.1	36.7	23.0

TABLE V

Age	Number of Individuals	Length of Head	Width of Head	Width of Face	Width of Nose	Cephalic Index
6	4	174.4	144.8	115.7	26.5	83.1
7	13	173.1	145.9	116.0	27.8	84.4
8	25	169.2	144.6	117.4	27.6	85.6
9	21	174.0	148.0	124.3	28.6	85.3
10	34	170.8	146.0	119.5	29.2	85.6
11	28	175.2	144.7	121.6	29.9	84.0
12	30	175.7	148.7	121.8	30.1	84.5
13	36	174.4	147.7	125.0	30.5	84.7
14	44	176.9	148.3	126.3	31.7	83.8
15	27	180.5	149.0	128.7	32.7	83.5
16	16	180.6	152.1	129.0	34.3	84.4
17	14	180.0	151.0	129.3	33.4	84.0
18	11	183.5	151.9	133.2	34.5	82.9
19	6	178.7	149.8	133.3	35.3	83.8
A I	35	190.6	151.3	135.9	34.2	79.7
A II	175	184.6	152.5	137.1	34.7	82.8
AIII	57	187.8	151.5	137.7	37.6	80.8

This, however, is contradicted by the peculiar behavior of the teeth. At the same time, when the measurements were taken, casts were made of the teeth of the children. These have been discussed by

TABLE VI.—STATURE OF BOYS

Age	Porto Rico	Mexico City ¹	Sicilians ²
6	1099	1100	1086
7	1143	1150	1141
8	1180	1196	1202
9	1243	1247	1263
10	1276	1290	1302
11	1308	1336	1329
12	1367	1375	1384
13	1384	1438	1427
14	1467	1491	1480
15	1522	—	1527
16	1580	—	1595
17	1603	—	1650
18	1645	—	1631
19	1620	—	1648

¹ After Dr. W. Gomez (*Anales de Higiene Escolar*, Vol. II, pp. 239-244, Mexico, D. F., 1913).

² After F. Boas, *Changes in Bodily Form of Descendants of Immigrants*, New-York, 1912, p. 20.

Mr. Leslie Spier.¹ It appears from his calculation that the eruption of permanent teeth among Porto Rican boys occurs about a year in advance of the eruption of teeth among Boston boys. For the purpose of comparison I give here a table showing the time of eruption of teeth in our series from Porto Rico; in a series from New York City, for which I am indebted to the kindness of Dr. Milo Hellman; and in a series of canines of boys from Saxony for which I am indebted to Doctor C. Röse (Table VII). It appears from these clearly that the

TABLE VII.—PERCENTAGES OF PERMANENT TEETH PRESENT IN THE UPPER JAWS

Boys															
Age	Canines					Age	First Bicuspid					Second Bicuspid			
	Porto Rico	Boston	New York Poor	New York Well-to-do	Saxony		Porto Rico	Boston	New York Poor	New York Well-to-do	Porto Rico	Boston	New York Poor	New York Well-to-do	
6	—	—	—	—	—	6	—	2	—	—	—	—	10	2	
7	—	3	3	—	1	7	4	2	14	2	8	11	8	—	
8	20	—	1	—	—	8	27	21	19	7	28	19	38	2	
9	30	—	8	—	2	9	54	39	46	11	32	32	47	20	
10	41	33	23	15	11	10	65	63	62	35	56	54	61	36	
11	62	61	42	45	32	11	83	76	77	66	79	55	85	63	
12	77	85	77	78	65	12	94	80	94	88	87	67	88	85	
13	89	91	100	85	82	13	95	87	99	97	99	77	97	88	
14	97	100	91	100	91	14	100	96	97	100	100	—	90	83	
15	100	100	86	100	100	15	100	100	96	100	97	—	?	100	

eruption of teeth among Porto Rico boys is considerably earlier than in the more northern countries. It cannot be stated definitely whether this is due to peculiar conditions of nutrition or of climate, or perhaps to pathological conditions, or what other cause may lead to the apparent contradiction between the results of our observations based on stature and of those obtained from a study of the condition of the teeth.

A comparison of parallel series of poor and well-to-do children in New York, and of feeble-minded and normal children in Boston² presents the same differences. Since in a homogeneous series the state of eruption of the teeth is an indication of physiological development, as proved by the correlation between stature and number of permanent teeth present,³—there must be other causes at work that bring about an acceleration of dental development under unfavorable

¹ *American Anthropologist*, N. S., Vol. 20, pp. 37 et seq.

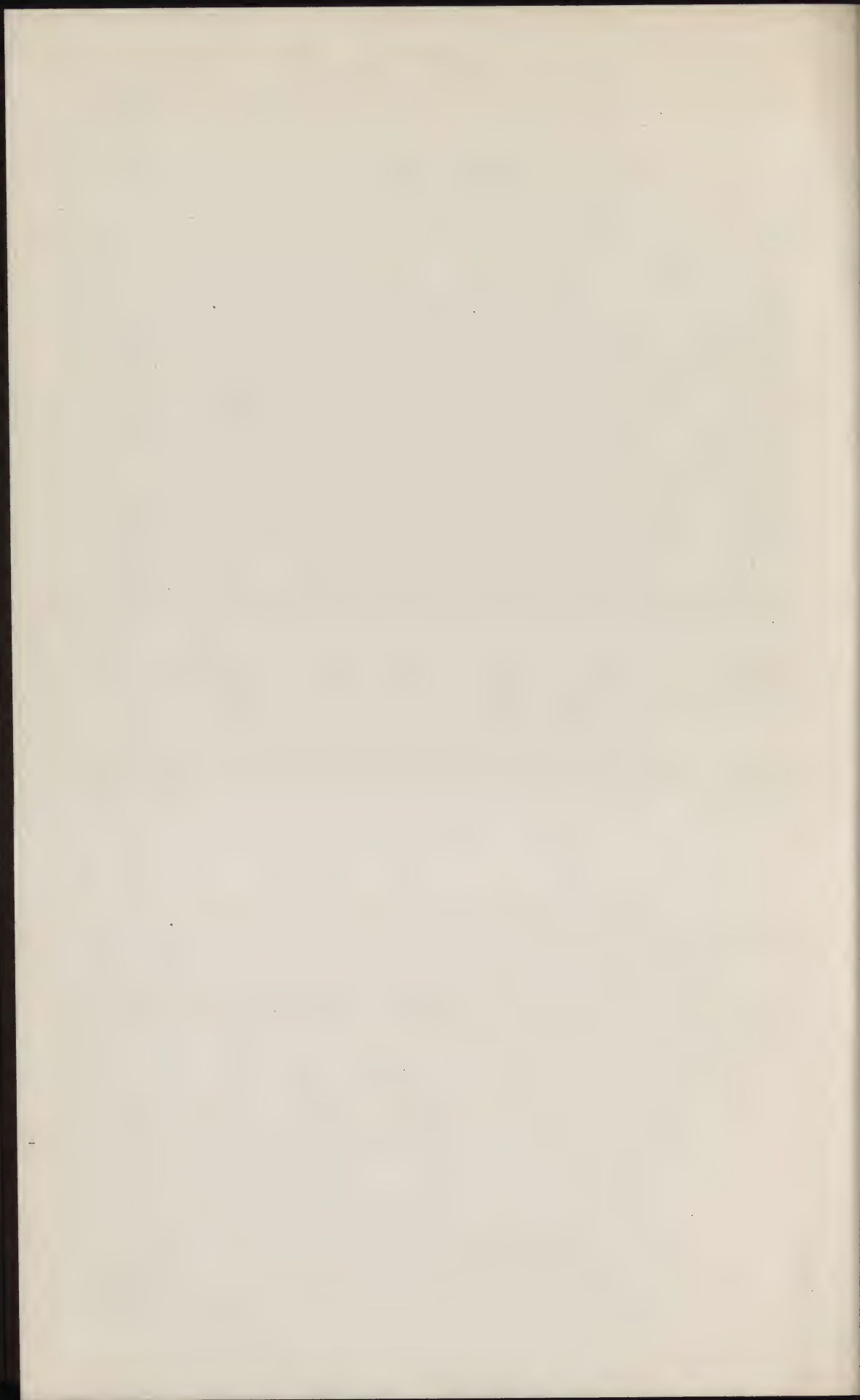
² Leslie Spier, "The Growth of Boys: Dentition and Stature" (*Am. Anthr.*, Vol. 20, p. 42).

³ *Ibid.*, pp. 42 et. seq

social conditions. I expect to revert to this phenomenon at a later time.

A consideration of the cephalic index shows that the Porto Rico boys and adults are throughout short-headed, while the Spaniards from whom they are in part descended are decidedly long headed. This difference appears particularly clearly when we compare the adults whose parents were born in Spain, the only group that has an index under 80, while groups born in Porto Rico have an index over 80. We have to consider here that the native population of Porto Rico, so far as it is known to us, was highly brachycephalic, and that if there were considerable admixture of native blood, the round headedness of the people might be explained in this manner. It seems to my mind, however, highly improbable that enough Indian blood should survive to account for the strong modification of type. A definite solution of this problem would be possible by the examination of a selected series whose ancestry is known accurately. According to the evidence that we can give at the present time, it seems not improbable that the change in head form may be a phenomenon similar to the change in head form which has been observed among European immigrants who settled in North America.¹

¹ See F. Boas, l.c.; C. E. Guthe, "Notes on the Cephalic Index of Russian Jews in Boston" (AM. JOURN. OF PHYS. ANTHR., Vol. I, pp. 213 *et seq.*)



DIFFERENCES IN THE PATTERN OF THE SECOND LOWER MOLAR TOOTH

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It is well known that the third upper molar and the second lower molar teeth are unstable in form, the former tending to become secondarily tritubercular and the latter secondarily quadritubercular. Accurate statistical data on the frequency of these transitions in the various types of mankind are not, with a few exceptions, easily accessible. For the most part such data lie buried in the body of larger craniometrical treatises and even here we find only occasionally accurate percentages based on a sufficiently large number of cases to warrant their being accepted as an indication of the true state of affairs. This is by no means the fault of the various observers but may be attributed in the most part to the condition of the skeletal material. In all collections of crania, mandibulæ are present in only a small percentage of cases. Of this number a large proportion has lost the teeth in life or after death, some even in the process of collecting and storing. In still another large percentage the teeth are worn to such a degree that relatively few remain suitable for the study of cusps and tooth patterns.

We have it on the authority of dentists that modern European man shows in a large majority of cases the secondary quadritubercular pattern in the second lower molar teeth. This observation is borne out by statistical studies in several collections of European crania. The hypoconulid disappears, leaving only the four cusps protoconid, metaconid, hypoconid, and entoconid.

This is apparently a late development since the Mauer mandibula shows the primitive five cusps in the second lower molars as do also certain Neanderthaloid mandibulæ. Cunningham says the second lower molar has four cusps as a rule, five in only 24 per cent of all skulls examined. Martin gives the occurrence of 5 cusps in 6 per cent of Europeans and 15 per cent of the Lapplanders. Schwerz gives the following data: five cusps in 73 per cent of the Australians, 34

per cent of Negroes, 3 per cent of Alamans and 2 per cent of Hungarians. The number of cases upon which these percentages are based is not stated. Hrdlička⁵² on the basis of teeth of the Munsey, Arkansas, Louisiana, Zuni and some Mexican Indians, gives the frequency of five cusps as 21 per cent; of $4\frac{1}{2}$ cusps as 25 per cent; and of 4 cusps as 54 per cent. But in 67 second lower molars of the Sioux he observed five cusps in 68 per cent, $4\frac{1}{2}$ cusps in 6 per cent, and 4 cusps in 36 per cent of the cases. In the male Sioux the proportion of the teeth with 5 cusps reached in fact as high as 77 per cent, that of 4 cusps being reduced to 20 per cent.

There are in the American Museum of Natural History two collections of mandibulæ especially favorable for the study of tooth patters. The first is a group of 43 Tarascan Indians from Mexico and the second a group of 30 crania from southern India. The latter collection consists largely of crania of the modified Mediterranean type similar to the Singhalese described by the Sarasin brothers. A few approach the Veddah type. Both of these series are made up almost wholly of young adults with complete dentition and show little or no wear.

The condition in the two groups are quite different. In the collection of Tarascan Indians from Mexico the second lower molar has 5 cusps in 76.8 per cent of the cases and 4 cusps in only 23.2 per cent. The mandibulæ from southern India on the other hand show five cusps in only 16.6 per cent of the cases and four cusps in 83.4 per cent. These results as well as those mentioned above may be summarized as follows.

NUMBER OF CUSPS ON THE SECOND LOWER MOLAR TEETH

Group	Number Exam- ined	Percentage		Author
		5 Cusps	4 Cusps	
Tarascan Indian (Mexico).....	43	76.8	23.2	Sullivan
Australian.....	?	73.0	27.0	Schwerz
Negro.....	?	34.0	66.0	Schwerz
Southern India.....	30	16.6	83.4	Sullivan
Laplander.....	?	15.0	85.0	Martin
European.....	?	6.0	94.0	Martin
Alaman.....	?	3.0	97.0	Schwerz
Hungarian.....	?	2.0	98.0	Schwerz

That the condition found in the Tarascan Indians may be taken as representative of the condition in at least some American Indians I feel fairly certain. It has been my experience that a second lower molar tooth with only four cusps is relatively rare in American Indians.

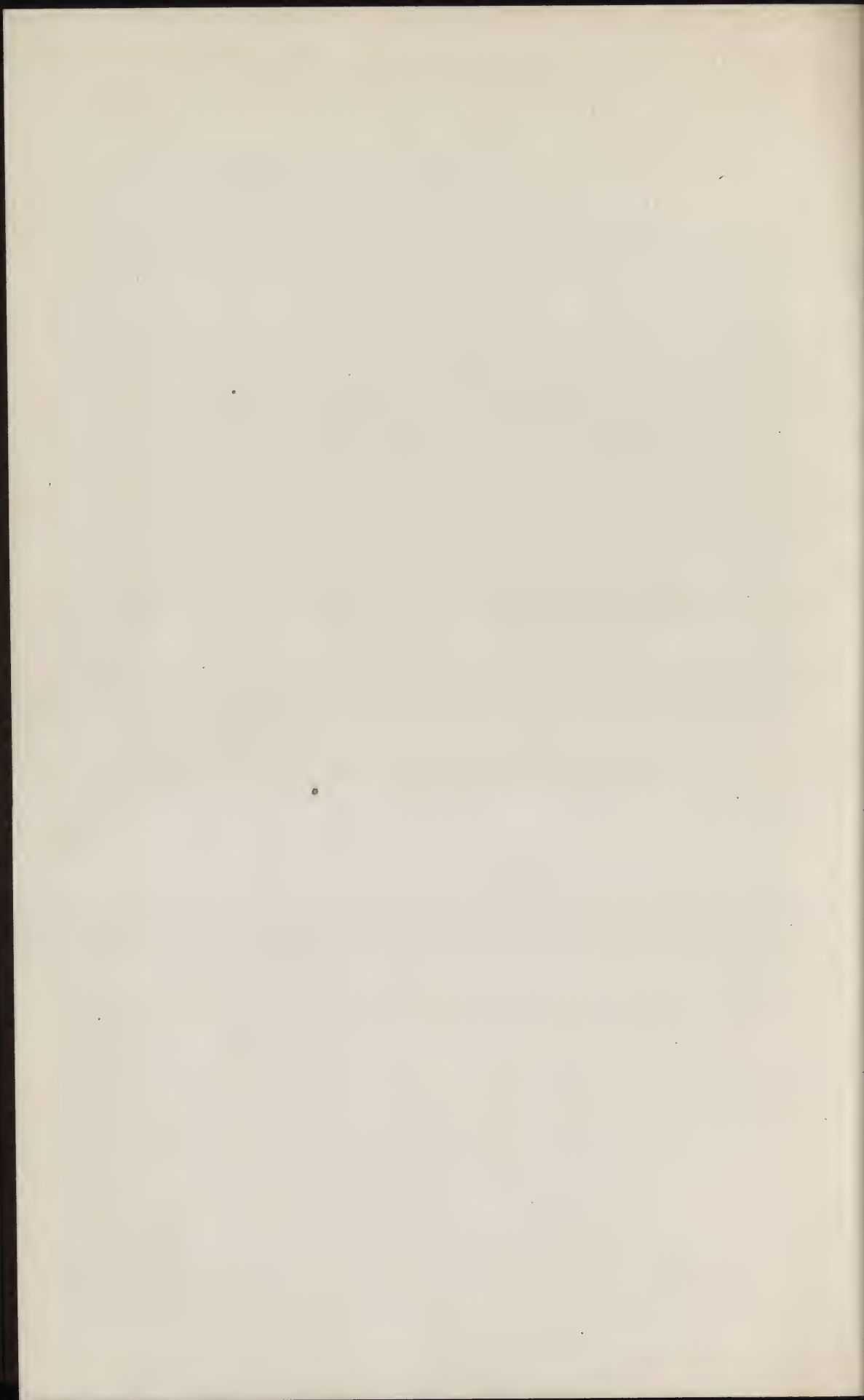
In the case of the Tarascan Indians the fifth cusp (hypoconulid) in question is in a majority of cases as large and well formed as is the corresponding cusp in the Mauer jaw and the tooth correspondingly large.

Whether the differences revealed in the above table are indicative of racial or functional differences is not quite clear. The Australians and the American Indians stand close together in this particular characteristic yet they are undoubtedly quite distinct racially. The Negro, famed for his supposedly perfect and primitive dentition, is apparently quite modern and specialized in this particular respect. The Europeans are uniform in showing a high percentage of cusp reduction. It is obvious that more detailed data are needed before generalizing on the cause of this reduction. From the above it is not altogether clear how closely this reduction is correlated with the diminution of function. While the skulls from southern India show a high percentage of cusp reduction their dentition can in no sense be considered degenerative. They show a very high percentage of normal occlusion and the teeth are in most cases well formed and free from caries.

The reduction in question is important from an evolutionary standpoint and worthy of separate study. It is for this reason that the above observations are placed on record. It is to be hoped that more data will be forthcoming on the Negroid and Mongoloid types.

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SEX TRANSFORMATION AND HERMAPHRODITES IN CHINA

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The following data are excerpted from Chinese records, chiefly the official historical annals, and may be of interest to some anthropologists and students of sexual psychology. As they are merely intended for the inner circle, I have deemed it superfluous to add a commentary. Those who are familiar with the writings of E. Laurent in particular will have no difficulty in understanding these phenomena. There is no doubt that under the heading of sex transformation different phenomena are involved, but the Chinese data are too succinct to admit a complete and positive interpretation in each and every case.

There are in the Chinese Annals numerous records of female chickens being transformed into males (cf., for instance, *Sung shu*, Ch. 30, pp. 14b, 15). Unfortunately we do not receive any details, and the Chinese hardly discriminate between primary and secondary sexual characters. "It is a singular fact," says Darwin,¹ in discussing the sexual differences in fowl, "that the males in certain sub-breeds have lost some of their secondary masculine characters, and from their close resemblance in plumage to the females, are often called hennies. There is much diversity of opinion whether these males are in any degree sterile; that they sometimes are partially sterile seems clear, but this may have been caused by too close interbreeding. That they are not quite sterile, and that the whole case is widely different from that of old females assuming masculine characters, is evident from several of these hen-like sub-breeds having been long propagated. . . . There is also a breed of Game-fowls, in which the males and females resemble each other so closely that the cocks have often mistaken their hen-feathered opponents in the cock-pit for real hens, and by the mistake have lost their lives." Note also his observation, "I may add that at the first exhibition of Poultry at the Zoölogical

¹ Variation of Animals and Plants under Domestication, I, p. 306 (Murray's ed., 1905).

Gardens, in May, 1845, I saw some fowls, called Friesland fowls, of which the hens were crested, and the cocks furnished with a comb."

"The transformation of women into males is not a fable (*ex feminis mutari in mares not est fabulosum*). We find in the *Annals* that under the consuls P. Licinius Crassus and C. Cassius Longinus (171 B.C.) it happened in Casinum that a virgin was transformed into a boy under the eyes of the parents and by order of the Haruspices was deported to a desert island. Licinius Mucianus relates that he saw at Argos a certain Arescon, formerly named Arescusa and even married to a man; soon after she grew a beard and produced other marks of virility, so that she then took a wife. The same author asserts that he saw a boy of the same condition at Smyrna. I myself saw in Africa a citizen of Thysdris, L. Consitius, who on the very day of her wedding with a husband had been changed into a man." Thus Pliny (VII, 4, § 36) reports in his *Natural History*.

Sex 'transformations' in human beings must have been observed by the Chinese at an early time. King Fang, a philosopher of the first century B.C., who made a special study of the ancient book of divination, the *Yi king*, indulged in some philosophical speculations on the subject and regarded it as a foreboding of evil; thus the transformation of a woman into a man augurs that worthless creatures will become kings. The following eleven cases are on record.

In the thirteenth year of King Siang of Wei (306 B.C.), a woman became transformed into a man. During the period Kien-p'ing (6-2 B.C.) of the Emperor Ai of the Han dynasty, there was a man at Yü-chang (Kiang-si Province), who changed into a woman, was married to a man, and gave birth to a son. In the seventh year of the period Kien-ngan (A.D. 202), there was a man in Yüe-swi (Sech'wan Province), who became transformed into a woman.—*Ts'ien Han shu*, Ch. 27 B, p. 23; *Hou Han shu*, Ch. 27, p. 4 ("Annals of the Former and Posterior Han Dynasties" respectively).

In the beginning of the period Ning-k'ang (A.D. 373-376) of the Emperor Hiao Wu of the Tsin dynasty, a woman, née T'ang, of Chou-ling (Hu-pei Province), was gradually transformed into a man.—*Sung shu*, Ch. 34, p. 29b ("Annals of the Liu Sung Dynasty").

In A.D. 886, a girl who had not yet her teeth, in the district of Mei, prefecture of Fung-siang (Shen-si Province), was transformed into a male. She died after ten days.—*T'ang shu*, Ch. 36, p. 22b.

In 1512, there was in a village of Shen-si Province a woman, who was transformed into a man and grew a beard. Subsequently she brought forth two sons.—*Shen-si t'ung chi* ("Gazetteer of Shen-si Province").

In 1547, there was in the prefecture of Ta-t'ung (Shan-si Province) a woman who became transformed into a man.—*Shan-si t'ung chi* ("Gazetteer of Shan-si Province").

In 1620, a man of Kwang chou (in Ho-nan Province), Wu Lo by name, married a woman of the family Ch'en; after several days she changed into a man and grew a little moustache.—*Ju-ning fu chi* ("Gazetteer of the Prefecture of Ju-ning").

In 1625, a woman, *née* Ma, of T'ung Ch'eng (Ngan-hwi Province) changed into a man at the age of seventy.—*Kiang nan t'ung chi* ("Gazetteer of Kiang-nan").

In 1631, a woman, *née* Li, of Hwa-t'ing (prefecture of Sung-kiang, Kiang-su) changed into a man.—*Ibidem*.

In 1638, a poor woman, *née* Sun, in the Home for the Old at Lo-yang (Ho-nan Province), at the age of over seventy, grew a moustache.

In regard to hermaphrodites, let us begin with Pliny again. "Men of double sex are also born, and these we call hermaphrodites; formerly they were called Androgyni ('men-women'), and were taken as prodigies; now they serve sensual purposes" (Pliny, VII, 3, § 34). In regard to the Androgyni, a tribe living in what is now Tripolis, Pliny (VII, 2, § 15) informs us after Calliphanes that they have a double sex and alternately cohabit with one another (androgynos esse utriusque naturæ, inter se vicibus coeuntes).

In Chinese sources I have found the following four cases on record.

In A.D. 306 a son was born to Sie Chen of Kwei-ki (prefecture of Shao-hing, Che-kiang). He had a large head covered with hair, and the two soles were turned up. In the upper part of the body he was shaped like a male and a female. At the hour of his birth he possessed the voice of a male. At the end of a day he died.—*Tsin shu* ("Annals of the Tsin Dynasty").

At the time of the Emperors Hwi and Hwai (A.D. 290-312) of the Tsin dynasty, there was in the capital Lo (in Ho-nan Province) an hermaphrodite (literally, "one in whom the body of a man and a woman is united"). He was capable of having sexual intercourse as a man or a woman, and was inclined to excesses. This is the result of a disturbance of the vital forces.—*Sung shu*, Ch. 34, p. 27b ("Annals of the Liu Sung Dynasty").

In the first year of the period Yüan-hi (A.D. 304), under the Emperor Kung of the Tsin dynasty, a man of Kien-ngan (Fu-kien) had no glans on his penis; it was straight and flat. From below his trunk he had the shape and body of a woman.—*Ibid.*, Ch. 34, p. 29b.

In A.D. 1436 there were in T'ai-ts'ang chou (Kiang-su Province) two hermaphrodites; people called them "the double-shaped."—*T'ai-ts'ang chou chi* ("Gazetteer of T'ai-ts'ang chou").

In the modern written language, the term for hermaphroditism is *yin-yang* ("combination of female and male elements"); also *tse hiung t'ung t'i* ("body in which male and female traits are united"), and *liang sing kü yu* ("being possessed of a double nature"). The hermaphrodite is accordingly styled *yin yang jen* or *yu yin yu yang* ("man with female and male qualities"), and *pan nan pan nü jen* ("an individual half man, half woman"). In the colloquial language of northern China we hear *er wei-tse* ("one with two tails"); in Amoy (in southern China), people speak of a *liang hing dzin* ("man of two shapes"), *poan-ts'i-hiong* ("half-female-male"), or *tsu ui ts'i hiong tsi dz'in* ("individual who can pose as a female or male"); the Cantonese say *pun nam nü ke yan* ("half-man-woman-individual") or *yam yeung ping yau tik* ("one who unites in himself female and male qualities").

H. Ramsay (Western Tibet, p. 61) states that hermaphrodites are not known in Ladākh. Ladākhis think ill luck is caused by human monstrosities, and it is therefore probable that these are killed as soon as they are born.

Hermaphrodites, as far as I know, have never found expression in Chinese art as in Greek sculpture (cf., for instance, S. Reinach, *Hermaphrodite*, in his *Cultes, Mythes et Religions*, II, pp. 319–337; M. Houel, *Pièces d'hermaphrodites conservées au Musée Dupuytren*, *Bull. Soc. d'Anthr.*, XIV, 1881, pp. 554–556). Chinese art is asexual and anti-sexual.

In the European literature on China I have not been able to find any allusion to the two subjects here treated. In India hermaphrodites seem to be better known. Thevenot (Travels, part 3, containing the Relation of Indostan, p. 23, London, 1687) writes that for the first time he saw hermaphrodites at Surat in India. "It was easy to distinguish them, for seeing there is a great number in that town, and all over the Indies, I was enformed before hand, that for a mark to know them by, they were obliged under pain of correction, to wear upon their heads a turban like men, though they go in the habit of women."

SPECIAL COMMUNICATIONS AND REPORTS

THE HEIGHT-WEIGHT INDEX OF BUILD IN RELATION TO LINEAR AND VOLUMETRIC PROPORTIONS AND SURFACE-AREA OF THE BODY DURING POST-NATAL DEVELOPMENT. By C. R. Bardeen, Professor of Anatomy in the University of Wisconsin. Contributions to Embryology No. 46. Extract from Publ. 272, Carnegie Institution of Washington, Mall Memorial Volume, 1919. P. 483-554.

AUTHOR'S REVIEW.

Individuals vary in size and in build. The size of the body as a whole is usually expressed in terms of height and of weight. Build is usually expressed in non-mathematical terms such as thin or fat, stocky or slender, short legged or long legged. The relative length of legs is sometimes indirectly expressed in mathematical terms by the ratio between sitting and standing heights. The relative bulk of the body is similarly frequently indirectly expressed in mathematical terms by the ratio between chest girth and stature. Other measurements of size and of build have been far less frequently utilized. Linear measurements of various parts of the body have, however, been taken on considerable groups of individuals. Such measurements are best expressed relatively in terms of ratio to stature. Measurements of volume of the body as a whole or of its chief parts have been comparatively infrequent. To express volume relative to stature the ratio between volume and cube of the stature should be taken. The volume of a given part of the body is best expressed relatively in terms of ratio to the volume as a whole or of volume estimated from body weight. The surface of the body has been measured even less frequently than the volume. To express surface relative to stature and to volume it is convenient to take the ratio between the observed surface-area and the surface of a block as tall as the body, square in cross section and of a volume that may be estimated from body weight.

This is expressed by the following formula: $S = K \left(2 \frac{W}{H} + 4 \sqrt{\frac{W}{H}} \right)$,

where S = surface-area, W = weight in grams, H = height in centimeters, and K is a constant. The Du Bois data give an average value for K of 1,237; the Meeh data give an average value of 1,444.

In estimating volume from body weight the specific gravity of the body offers difficulties since the results obtained by various investigators differ considerably. For the sake of convenience a specific gravity 1.025 may be used when dealing with inch-pound units. The average specific gravity of the adult body in moderate expiration is probably not far from this figure. A pound of flesh thus represents a three inch cube. In dealing with metric units it is more convenient to assume that a gram of flesh has the volume of a cubic centimeter although this gives a lower and probably less accurate specific gravity than that chosen for the inch-pound units.

The purpose of the monograph under review is to summarize some of the chief data concerning relative linear, surface-area and volumetric proportions of the body during post-natal growth and to point out the correlations between these relative measurements and a height-weight index of build based on dividing body weight by cube of height.

It is shown that in the absence of other data, data on stature, weight, and age enable one through the use of the height-weight index of build to express relative build much more definitely than through use of such terms as slender or stocky. The height-weight index of build thus has value in human anatomy as well as in anthropology.

For the sake of convenience the height-weight index of build when inch pound units are used is taken as 1,000 times the quotient obtained by dividing the weight by the cube of the height. This index has 36.13 times the value of the index obtained by dividing the weight in grams by the cube of the stature in centimeters.

During post-natal development the height-weight index alters with changes in the proportions of the body. Tables 3 and 4 illustrate these changes:

TABLE 3

	Infant	Child	Youth
Stature.....	21 inches	42 inches	63 inches
Weight.....	8.5 lbs.	39.3 lbs.	104.5 lbs.
Index of build.....	0.918	0.530	0.418
Estimated volume.....	229.5 cu. in.	1,061.1 cu. in.	2,821.5 cu. in.
Relative volume of:			
Head.....	0.280	0.164	0.082
Trunk.....	0.495	0.523	0.523
Lower extremities.....	0.135	0.226	0.292
Upper extremities.....	0.090	1.087	0.103
	1.000	1.000	1.000

TABLE 4

	Mature Man	Mature Woman	Old Man
Stature.....	67.5 inches	63 inches	67.0 inches
Weight.....	148 lbs.	127.5 lbs.	155 lbs.
Index of build.....	0.481	0.510	0.515
Estimated volume.....	3,996 cu. in.	3,442.50 cu. in.	4,185 cu. in.
Relative volume of:			
Head.....	0.071	0.068	0.070
Trunk.....	0.542	0.517	0.573
Lower extremities.....	0.285	0.320	0.265
Upper extremities.....	0.102	0.095	0.092
	1.000	1.000	1.000

Considerable space in the monograph is devoted to an analysis of data on changes in the linear proportions of the body during development. These changes in linear proportions are correlated with changes in the height-weight index of build. It is pointed out that the square root of the metric index of build or the square root of a tenth of the inch pound index of build makes a convenient index for estimating relative widths and girths.

In conclusion it is pointed out that:

1. The height-weight index is altered by the changes in external form which characterize post-natal morphogenesis in all individuals, by "physiological age."
2. The height-weight index is influenced by sexual peculiarities of structure.
3. The height-weight index is influenced by inherited individual racial peculiarities of structure which may manifest themselves at any period of the life-cycle.
4. The height-weight index is influenced by peculiarities of structure due to habits of living or to environment.

The article is illustrated by two text figures and eleven charts and contains numerous extensive tables in which some of the more important literature is summarized from the standpoint of relative proportions of the body during growth.

BIRTH STATISTICS.

Third Annual Report, Bureau of the Census. Wash., 1919, 4°, 299 pp.

This is the third annual report on Birth Statistics published by the Bureau of the Census which presents statistics of births based upon data obtained from birth registration records, although statistics

of births based on information obtained by census enumerators or from mortality returns were published in connection with reports for each decennial census from 1850 to 1900, inclusive.

The birth registration area is now estimated to contain 53.1 per cent of the population of the United States. In this area in 1917 there were 1,353,792 living births, which represent a birth rate of 24.6 per 1,000 population as against 818,983 living births reported in 1916, with a rate of 24.8. Of these births, 696,101 were males and 657,691 were females, or a proportion of 1,058 males to 1,000 females.

The birth rate exceeded by 10.5 per thousand the death rate, which was 14.1 per thousand for the same area. The birth rates for the registration states ranged from 14.7 in Washington to 31.3 in North Carolina, and the death rates ranged from 7.6 in Washington to 17.1 in Maryland. The greatest excess of births over deaths—20.3 per 1,000 population—appears for Utah, and the lowest—4.7 per 1,000—for New Hampshire.

The birth rate (24.6 per 1,000 population) for the birth registration area as a whole in 1917 is slightly less than the rate for 1916 (24.8).

From a comparison between the proportion which the number of white foreign-born mothers formed of the total number of white mothers to whom children were born in 1917, and the proportion which the white foreign-born married women, aged 15 to 44, formed of the total number of white married women of corresponding ages in 1910, it appears that far more births occur annually to white foreign-born married women, aged from 15 to 44, proportionally to their number, than to native white married women of corresponding ages. The average number of children born to native mothers is 3.1 and the average number living is 2.8; for foreign-born mothers the same numbers are 3.8 and 3.2. Mothers born in Germany show the largest families (4.5), and also have the greatest number living (3.9). The colored population shows the same conditions as the foreign-born (3.8, 3.2), but the data are less reliable.

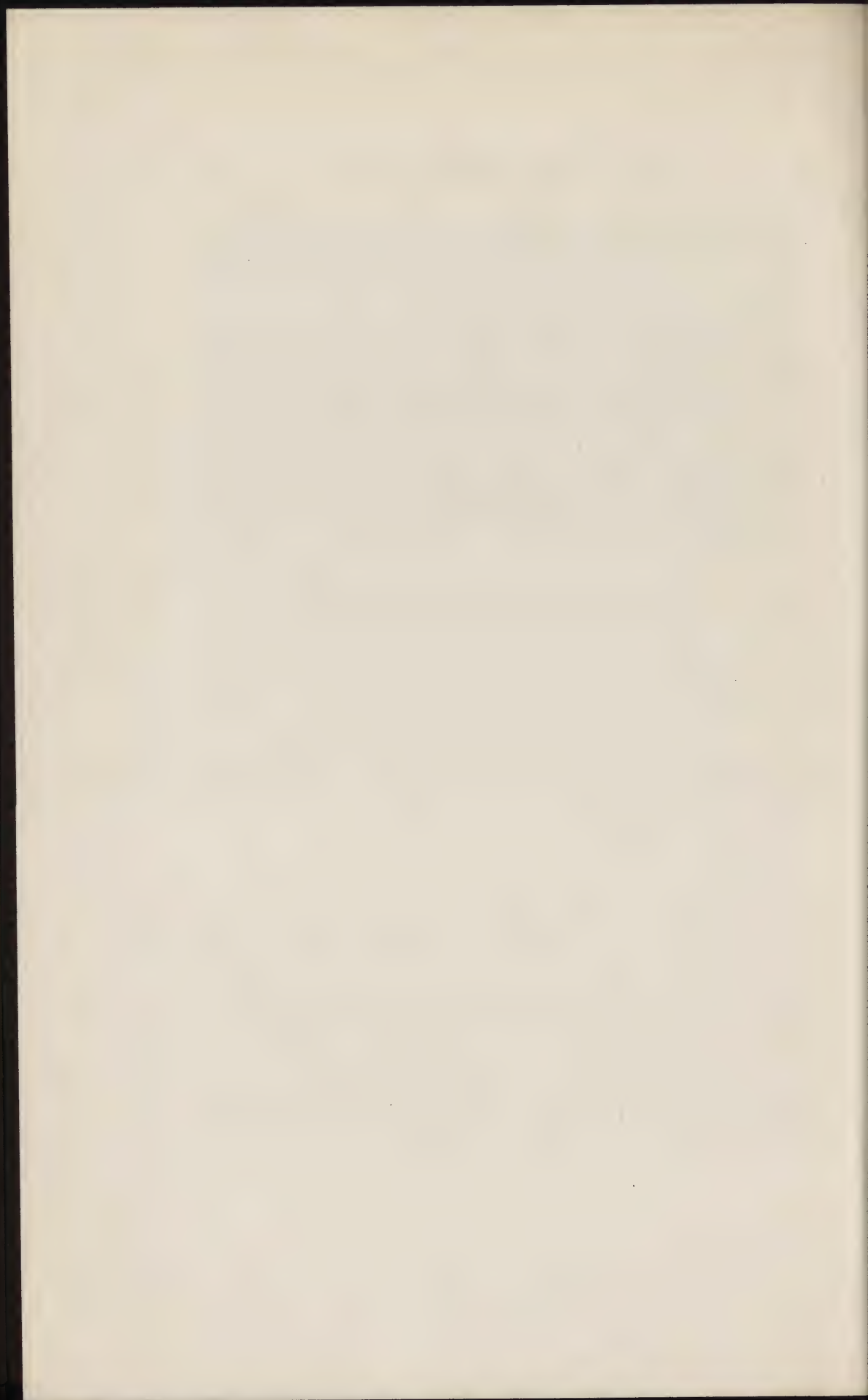
Plural births were in the proportion of 10.9 per 1,000 of births in general (1915, 1916, 10.1). There were 155 births of triplets.

The greatest number of children born in 1917 were to mothers in the age period 20-24, while the age of the father was somewhat higher, falling into the 25-29 age period.

The number of illegitimate births vary from 7.1 per 1,000 of births in Kansas to 53.5 in Virginia. The exceptionally high rates in Virginia, North Carolina and Maryland are due to the great number of

illegitimates among the colored people. The highest rate for illegitimate children of foreign mothers appears for those of Ireland (12.1), while the lowest (1.9) is for those born in Italy. However, it is possible that accurate information regarding illegitimacy may not always be given on birth certificates.

The rate of infant mortality for the birth registration area as a whole was 94 in 1917, as against 101 in 1916. It ranged from 67 in Minnesota to 120 in Maryland. As to nationalities, the rate ranges from 66 where mothers were born in Denmark, Norway and Sweden, to 173 where mothers were born in Poland (not specified); Negro children have a rate of 149. The range of rates among white males is from 74 for children of mothers born in Denmark, Norway and Sweden to 190 for those of mothers born in Poland (not specified); Negro males have a rate of 164 and the corresponding rates for females are 58, 153, and 132.



LITERATURE

EARLY MAN

VORGESCHICHTLICHE MENSCHLICHE FUNDE AUS STILLFRIED. By Schürer v. Waldheim (H.)—*Mitt. anthropol. Ges.*, Wien, 1919. XLVIII, 247.

A great deal of prehistoric material has been found on the river Morava (March), near the former Austro-Hungarian boundary and was described chiefly by Much. The present paper deals with the skeletal material (mostly skulls) of this place. They comprise 1 skull of the Neolithic, 13 skulls of the early Bronze period, 16 of the Hallstatt period and 1 incomplete skeleton of the La-Tène period. The neolithic skull shows in general the Alpine type. The average cephalic index of the Bronze age series is 76.6; these skulls are large and massive. Among the Hallstatt material it is noteworthy that there exist very marked differences between male and female skulls. In the La-Tène skeleton special attention is paid to the humerus, which shows a condition resembling the one found in cretinism. After detailed comparison of normal and cretinoid humeri with those of different human races and also of apes the author concludes that these "cretinoid" signs of the humerus of the La-Tène skeleton (and also of some humeri of Schweizersbild) are not pathological but a primitive condition as found for example in Bushmen.

A. H. SCHULTZ.

ONTOGENY

ANLAGE UND ENTWICKLUNG DES MAXILLARE UND PRAEMAXILLARE BEIM MENSCHEN. By Felber (P.) *Gegenb. Morph. Jahrb.*, 1919, L, 451.

There is one premaxilla (os incisivum) on each side. Maxilla as well as premaxilla have each only one ossification center, the one for the former appearing at the end of the sixth, the one for the latter at the beginning of the seventh, week of intrauterine life. At the end of the seventh week these two ossification centers have fused on the facial side of the alveolar wall. In the growth of these two bony elements a certain independence of each other is manifested inasmuch as a maxillary and a premaxillary processus frontalis grow parallel upwards, separated by a continuation of the sutura incisiva. The fusion of these processes begins in the eighth week at their lower end and gradually extends upward. The ossification of the palatal side occurs later and more slowly; here the sutura incisiva separates the maxilla and premaxilla for a considerable time. In most cases this suture runs between the lateral incisor and the canine, but may at times cut into

the alveolus of either of these teeth. The sutura interincisiva forms at the place where the processus palatinus lateralis and medialis of the premaxilla meet; sometimes this suture is found missing altogether. The sutura interalveolaris separates the facial alveolar wall of the premaxilla from the processus palatinus medialis of the same bone. This suture and the interincisiva disappear after the fifth month, but the latter is not infrequently found to persist. In most the cases the part of the sutura incisiva adjoining the foramen incisivum remains open. Congenital clefts of the palate are in the opinion of the author due to anomalies in the developing teeth and may therefore vary in their location.

A. H. SCHULTZ.

NOTES ON THE POSTNATAL GROWTH OF THE HEART, KIDNEYS, LIVER AND SPLEEN. By Bean (Robert Bennett)—Carnegie Inst. of Wash., 1919. *Contrib. to Embryol.* No. 37, 263-284

The materials include the weight of the organs from 255 white female children, 361 negro female children, 366 white male children, and 419 negro male children below the age of 21 years. No attempt was made to select only normal organs, but where an organ is obviously diseased, so as materially to affect its weight, it is discarded.

The rate of growth is determined from the weight of the organ preceding the periods of rapid growth; that for the first 2 years is based upon the weight of the organ at birth, the other periods begin at 2, 10, and 18 years respectively. Each organ has a period of rapid growth immediately after birth, a second period from 2 to 8 years, and a third period about puberty. Each of these periods alternates with one of slow growth. As growth proceeds each organ becomes either large or small, depending upon the type of individual. There are changes in size due to the state of nourishment and to pathological conditions of the individual without specific disease of the organ; race and sex also influence the size of the organs. They are larger in boys than girls although the organs are generally larger in girls at the age of ten years than in boys at that age due to the precocity of the girls. The most characteristic racial difference is found in the spleen, which is larger in the white than in the negro.

The growth of the heart is slower during the first two years than is that of the spleen, liver, or kidneys; but after that time, until maturity is reached, the rapidity of its growth is relatively greater than that of the other organs. The initial increase in growth, *i.e.*, 3 to 12 months, is greater and more rapid in the kidneys than in the other organs, and their maturity seems to be reached earlier, or at about the age of 15 years, although during the periods after the second year the kidneys grow relatively less than the spleen, and the spleen relatively less than the liver. Attention is called to the great importance of collecting the following data: Age, sex, race, type, relation to puberty, habits, heredity, nourishment, pathology, cause and condition of death.

R. B. B.

SOME GRAPHS AND TABLES ILLUSTRATING THE GROWTH OF THE HUMAN STOMACH. By Scammon (R. E.)—*Am. Jour. Dis. Child.*, 1919. XVII, 395-422.

The weight of the stomach in the latter part of the third fetal month is 0.125 gm. In the early part of fetal life the organ approximately doubles its weight with each fetal month. The rate of growth in the last third of fetal life is about 40 per cent. per month. The average weight of the organ in the newborn is about 6.5 gm. The natal weight is about doubled in the first trimester of post-natal life and is more than tripled by the end of the first year. The increase in the weight of the organ between birth and maturity is about twenty-four fold.

The anatomic capacity of the stomach, as determined by all the simpler methods, is about 30-35 c.c. at birth. This is tripled in the first months, and increased six fold by the close of the third trimester. The average physiologic capacity of the stomach, as determined by weighing the child before and after feeding, does not differ greatly from the anatomic capacity during the suckling period. The average physiologic capacity of the stomach for the greater part of the first year may be expressed by the (empirical) formula $C = 75 + 4N$, where C is gastric capacity in grams or cubic centimeters and N is the age in weeks.

R. E. S.

CHILDHOOD

STANDARDS OF CHILD WELFARE. A report of the U. S. Children's Bureau Conferences, May and June, 1919, 8°. Wash., 459 pp.

This report contains no less than sixty papers by prominent workers in Child Welfare, besides valuable discussions. Papers which are of more direct anthropological importance are those on "Racial Factors" by Prof. Kelly Miller (66-70); on Physical Standards of Working Children by Owen R. Lovejoy (81-86) and Dr. Emma MacKay Appel (86-90); the "Serbian Experience" (gives War Statistics) by Dr. R. M. Lazarevitch (173-175); "Nutrition Clinics" by Dr. Wm. R. P. Emerson (238-247); "Health Examinations" by Dr. Thos. D. Wood (248-255); "The Nutrition of Adolescence" by Dr. Graham Lusk (256-261); "A Physical Classification of Children" by Prof. F. Frassetto (292-302); and "Minimum Standards" (433-444).

CERTAIN DEFECTS IN AMERICAN EDUCATION AND THE REMEDIES FOR THEM. By Eliot (Charles W.)—Teacher's Leaflet No. 5, U. S. Bureau of Education. June, 1918, 8 pp.

"Sporadic medical inspections of school children and the medical examinations of young men drafted for the National Army have revealed in children and young men between 21 and 31 a large percentage of serious bodily defects which in many cases impair the capacity of the children to work efficiently in school and of the young men to serve satisfactorily in the Army or Navy. The percentage of defective

bodies in both school children and young men drafted for military and naval service has surprised and mortified the American public. It is some consolation that many of the defects and disorders in the school children are remediable, but thus far the organization and enforcement of remedial processes are by no means sufficiently general to cope with the existing evil. Most of the attempts at remedy are municipal only. The Nation and the States have not yet attacked the grave problem in earnest. The remedies for the large percentage of abnormal and diseased school children and young men of the draft age are of course medical, including all the agencies grouped under the head of preventive medicine and public health." They are discussed with some detail in the rest of the pamphlet, with especial regard to diet, infant mortality, alcoholism, venereal diseases, mental defects, and ignorance.

HEREDITY

WHO SHALL INHERIT LONG LIFE? By Bell (Alexander Graham)—Repr., *Nat. Geog. Mag.*, June, 1919, 505-514.

"Longevity itself is not a thing that is capable of direct inheritance; but the fact that longevity seems to run in families shows that a *tendency* to long life can be inherited. It is not longevity itself that is transmitted, but something else that tends to produce long life. What is really inherited is probably a tough, wiry constitution, which enables the fortunate possessor to survive the multitudinous ills that flesh is heir to and live on to the extreme limit of human life. From this point of view, the attainment of old age is extremely significant.

"The people who live to be old represent the *disease-resistant* strain of their generation; and, on account of their superior fecundity, this disease-resistant quality is distributed very largely through the population. The weak and delicate do not, as a rule, live very long; nor are they capable of bearing large families. It is the strong and vigorous who live to extreme old age and leave many descendants behind them. The children of long-lived parents are, on the average, stronger, more vigorous, and longer-lived than the children of others; *and there are more of them per family*. Here, then, we have evidence of the existence of a natural process at work among human beings tending to improve the vigor and vitality of succeeding generations."

VARIATION

ANTIKE PORTRAITS. By Delbrueck (Richard)—Bonn, 1912, 4°. LXX pp., 28 fig., 62 pl.

Though belated, this publication deserves notice on account of its very considerable interest to anthropology. It brings a large series of excellent reproductions of antique portraits from statuary, wood carvings, coins and medals. It includes Egyptian, Greek and Roman portraits of prominent men and women, together with many pages of explanatory text and numerous references. While the subject has

been treated from the standpoints of history and art rather than that of science, the portraits will nevertheless be very useful to the anthropologist studying the people of classic antiquity.

DIE BILDNISSE DER RÖMISCHEN KAISER UND IHRER ANGEHÖRIGEN. By Stückelberg (E. A.)—Zurich, 1916, 16mo, XV pp., 171 pl.

A collection of portraits, from coins and statuary, of Roman caesars and members of their families. Many of the portraits are of decided interest to physical anthropology. Some show plainly the early platy-brachycephalic type, which is so un-Italian and the origin of which has not as yet been satisfactorily explained. There are also types that seem to connect with Greece and Asia Minor; and among the later emperors and their wives there appears a mixture of various racial elements. The little album supplements nicely Delbrueck's larger work on the subject (see preceding reference).

ZUR MORPHOGENESE DES EPICANTHUS UND DER FALTENBILDUNGEN DER HAUT IN DER NASENWURZELGEGEND. By Forster (A.)—*Anat. Anz.*, 1919. LII, 49-63.

Discussion of the different theories concerning the causation of epicanthus and report of some cases with this condition. The author's conclusion is that epicanthus is found in brachycephalic heads with very little developed arcus superciliares and with flat, low nasal bridge. Arteria and vena frontalis or the musculus procerus nasi may in rare cases give rise to folds resembling epicanthus.

A. H. SCHULTZ.

THE DEVELOPMENT OF THE EXTERNAL NOSE IN WHITES AND NEGROES. By Schultz (Adolph H.)—*Contrib. to Embryology*, No. 34., 1919, 173-190.

This study is based on measurements and observations on 320 human fetuses and deals with the conditions of growth of the external nose, which were found to differ in whites and negroes.

The decrease of the relative nasal height as well as the relative nasal breadth with advancing fetal age shows that the size of the nose diminishes in relation to the size of the face during intrauterine development. The growth of the height of the nose exceeds that of the breadth, which fact is proved by the steadily decreasing nasal index. The relative interocular breadth becomes less in the growing fetus, and this to a greater degree than the nasal breadth; therefore the breadth of the nose manifests a less active growth in its upper part. Besides these general rules, which hold good for both races, differences in the nose of whites and negroes are found to exist during the entire fetal period. One of the most marked points of distinction is the nasal breadth, which is greater in negroes, absolutely as well as in relation to the facial breadth. Further differential characteristics are the blunter nose of the negro fetus and the mostly transverse

position of the nostrils in this race. The variability in form and in size of the external nose of fetuses is very considerable in all stages.

A. H. S.

CONTRIBUTION A L'ÉTUDE DES CORRELATIONS PHYSIQUES ET PSYCHO-SOCIOLOGIQUES DE LA CIRCONFÉRENCE CÉPHALIQUE. By Constantin (M. André).—*L'Anthropologie*, Paris. XXIX, Nos. 3-4, 265-288.

Basing his conclusion on the results of comparisons of measurements of head circumferences in various classes of the French population, the author states that "everything else being equal, the individuals who have gone through courses of studies and who are habitually engaged in intellectual work, present, on the average, a larger circumference (and consequently larger size of the head and brain) than those who have not been occupied thus. On the other hand, in the uneducated or semi-educated the mean cephalic circumference is below the general average." Among the most highly educated the size of the head appears to augment in accordance with the difficulties of the studies and the total amount of knowledge acquired. In all these groups individual variations are, however, very large. A comparison of the mean circumference of the blondes, brunets and intermediary classes seems to point to the superiority of the mixed class over the two others.

The study, while not based on as precise and extensive measurements as might be desirable, confirms, nevertheless, former observations in the same directions.

The examination of a number of French emigrants from America did not sustain in any way the theory of a preponderance of the dolichocephalic element in immigration. The French-Americans presented all the brachycephalic types common in the regions from which their families were derived.

SEXUAL DIFFERENCES IN THE SKULL. By Parsons (F. G.) and Mrs. Lucas Keene.—*J. Anat.* (Lond.), 1919, LIV, 58-65.

In a large number of simple but rather ingenious tests on post-mortem material, the authors find that "8 mm. is a good allowance for the soft parts in both the length and breadth of the skull"; and that "in practice the change from the cranial to the cephalic index means an addition of 1 per cent." So far as sexual differences are concerned, an extended series of observations leads the authors to the following conclusions: "(1) That the female skull is shorter in proportion to its breadth than is the male by 2 per cent and that this difference is not fully accounted for by the greater development of the frontal sinuses in the male. (2) That in those series of artificially sexed skulls in which this proportion is markedly departed from the sexing has probably been unsuccessful. (3) That the facial index does not differ in the two sexes. (4) That the female skull is lower in proportion to

its width than the male by from one to two per cent when the auricular height is taken. (5) That the female skull is some 8 mm. narrower in the width of the palate than the male. (6) That the zygomatic arches are wider in proportion to the maximal breadth of the skull by 4 per cent in the male than in the female."

SUR QUELQUES VARIATIONS DES OS "DES CRÂNES GRECS ANIENS." By Koumaris (J. G.)—*L'Anthrop.*, 1919, XXIX, 29-36.

Observations on old Greek skulls in the Anthropological Museum at Athens.

Third condyle was present in but 1.1 per cent of the crania (539) that could be examined for this feature. Uni- or bi-lateral *precondylar processes*, not happily called "pseudo-condyles" by the author, were present in 5.4 per cent. A large Inca bone ("os interparietal") was present in but one out of 653 crania; but what the author calls "os epactal," i.e., a smaller separate bone, was present in 78 cases or 11.9 per cent. A bregmatic bone was observed 7 times in 646 skulls (1.1 per cent); metopic suture in 68 out of 677 skulls (10.4 per cent); a K-pterion in 5 (4 male, 1?) out of 581 skulls (.86 per cent); and I-pterion in 15 (14 male, 1?) of which 7 were uni-lateral, in the same number of specimens (2.6 per cent). Pteric bones were found in 133 crania (108 male, 9 female, 16?) or 23.6 per cent (in 76 uni-lateral).

RACIAL MISCELLANEOUS

ZUR PHYSISCHEN ANTHROPOLOGIE DER ALBANESEN. By Haberlandt (A.) and Lebzelter (V.)—*Arch. f. Anthropologie*, 1919. XVII, H. 3 & 4, 123-154.

On a trip to Albania, Montenegro and Serbia, Haberlandt measured (body height and head measurements) and examined 140 Albanian soldiers. This material showed an average body height of 169.2 cm.; the lower extremity seemed to be remarkably long and the muscles of the calf underdeveloped. In 2.8 per cent of the cases the head was dolichocephalic; in 12.1 per cent, mesocephalic; in 29.2 per cent, brachycephalic; in 42.1 per cent, hyperbrachycephalic and in 13.5 per cent, isocephalic. All the heads were very high. The forehead of the Albanian is broad and high; the face is high and the malar region rather prominent. The root of the nose shows no saddle; it is unusually high and as a rule narrow. The nasal profile is mostly straight or convex. The mouth is small with thin lips. According to the authors' conclusion the population of Albania is a mixture of two types, one of dark complexion and another of light complexion. The former is represented in the majority of the cases, partly on account of its dominant character.

A. H. SCHULTZ.

STUDIES ON THE ADAPTATION OF MAN TO HIGH ALTITUDES. By Sundstroem (Edward Sigfrid).—*Univ. of California Press*, 1919.

While not directly of anthropological nature, the publications of Dr. Sundstroem deserve to be noted in this place, for they have bearing on the possible changes in man's functions, and perhaps also physique, by environment. The results of the research are published in short papers which will doubtless eventually be united into a volume. Those which have so far appeared comprise (1) Effect of High Altitudes on Pulse, Body Temperature, Blood Pressure, Respiration Rate, Output of Urine, and Loss of Energy in Feces; (2) Effect of High Altitudes on Protein Metabolism; (3) Effects of High Altitudes on the Iron Metabolism; (4) Effect of High Altitudes on the Carbon Dioxide Content and on the Hydrogen Ion Concentration of the Blood; (5) Effect of High Altitudes on Salt Metabolism with Special Reference to the Mechanism of Maintaining the Acid-base Equilibrium of Body; (6) Effect of High Altitudes on the Number of Erythrocytes; (7) Effect of High Altitudes on the Size of the Erythrocytes and (8) Effect of High Altitudes on the Morphology of Red and White Blood Corpuscles.

VANISHED ISLANDS AND PEOPLES. By Brown (J. MacMillan).—*The Press*, Christchurch, New Zealand, Sept. 20, 1919.

In an interesting three-column article, which would deserve to be published elsewhere, the author refers to a number of traditions and historical accounts of vanished islands and peoples in the Pacific. The instances mentioned are those of three small islands, densely populated, in the Cook group; Malden, and perhaps some other islands in somewhat the same longitude but ten or twelve degrees nearer the equator, with some remarkable archaeological remains; and other islands with peoples in other parts of the Pacific.

DEMOGRAPHY

INFANT MORTALITY. By Dempsey (Mary V.)—Pub. No. 37, Children's Bureau, Ser. No. 8, Wash., 1919.

This is a report of the results of a field study in Brockton, Mass., based on births in one year. "During the year selected for this study Brockton had an infant mortality rate of 96.7, which is relatively low compared with other manufacturing cities having similar climatic conditions. This low rate has been attributed to the high wages paid by the dominant industry of the city, the intelligence of the workers, the fact that very few mothers were gainfully employed away from home, and the generally good municipal sanitation. But when the infant mortality rates of other cities of similar size and the general type of population are considered, the Brockton rate does not seem to be commensurate with the advantages generally enjoyed throughout the city.

"The mortality among babies of foreign-born mothers was lower than among babies whose mothers were native Americans. Few, if any, New England manufacturing cities have shown similar results. To a certain extent this favorable condition is due to the fact that most of the foreigners who come to Brockton with their families are skilled workmen. Furthermore, they are not obliged to live under extremely poor housing conditions, as in more congested cities.

"With all the advantages existing in Brockton the infant mortality rate should have been lower than it really was. One must remember, however, that the city has developed very rapidly, having been incorporated only 32 years at the time of this inquiry. During that time remarkable progress has been made along the lines of sanitation and civic betterment, and improvements along every line of city activity were being pushed with much energy."

SOME VITAL STATISTICS. Based on the histories of 4,000 Chinese families. By Lennox (William G.)—*China Medical Jour.*, July, 1919. 20 pp.

The information upon which this report is based was collected by questioning the married men of the middle and lower classes of Peking's population who came to the Union Medical Dispensary. Allowance has been made as far as possible for errors introduced in mortality tables due to a probably higher percentage of such diseases as syphilis and tuberculosis among the clinic cases than in the general population. The author thinks the greatest source of error is to be found in the inaccuracy of the answers to the questions. Due allowance has been made also for the difference between Chinese and foreign methods of reckoning age.

It was found that there is no evidence that girl babies are destroyed at the present time in Peking, but the lower male death rate in the first year or two of life may point to a neglect of female children. The following is the author's summary of his findings:

"1. Of the 4,000 men questioned, almost one-fourth reported that they had had no children and almost one-half said that they were without living male offspring. Of 4,042 families with children represented by this series and Dr. Gray's series, the average number of living births per family reported was 3.2, of whom 1 had died, leaving 2.2 living. In the series here reported, not only was the average size of the family moderate, but there were few families with many children.

"2. There was a great excess of male over female births reported.

"3. One-fourth of the men admitted venereal infection.

"4. Of this series, counting all ages of children, one-third were reported as having died. Of Dr. Gray's series, one-half had died. Of the two series combined, not quite four out of ten had died.

"5. The calculated infant mortality rate as reported was between 118 and 184 (*i.e.*, between 11 and 18 per cent had died under one year of age).

"6. The female infant mortality rate exceeded that of the male, which is the reverse of the condition usually found.

"7. Of the men, 5 per cent said they had been married more than once; less than 1 per cent had had two or more coexistent wives.

"8. More of the men reported that they had been married at nineteen than at any other age, though the average age at marriage was twenty."

DAVIDSON BLACK.

PATHOLOGY AND TERATOLOGY

EIN MINIATURKIND. By Brüning (H.)—*Anatom. Hefte*, 1919, LVII, 1. Abt., 285.

Report of an extremely small infant. The grandparents of this child were cousins. The parents and their first two children are normal. The third child, with which this paper deals, was born 14 days sooner than expected; otherwise the pregnancy followed a normal course. At birth the child weighed only 1,500 gr. and had a length of 39 cm. It died at 18 months, showing at that age the following well-proportioned measurements:

Body height: 48 cm. (normal for this age approx. 75 cm.); head circumference: 37 cm.; chest circumference: 30 cm.; arm length: 20 cm.; leg and thigh length: 20.5 cm.; shoulder width: 10 cm.; body weight: 2350 gr. (normal, approx. 12,500 gr.).

The mentality was equal to that of normal children of corresponding age. Ossification at 18 months was at the state of normal ossification at birth. The autopsy showed that the child was normal (including the glands of internal secretion) except for slight rachitic changes in the bone cartilage border of the ribs. Syphilis, tuberculosis, fetal chondrodystrophy or osteogenesis imperfecta can be excluded as pathogenetic agents.

A. H. SCHULTZ.

UEBER DAS VORKOMMEN ÜBERZÄHLIGER MAMILLEN UND KOMBINATION DERSELBEN MIT ANDEREN DEGENERATIONSZEICHEN. By Boenheim (F.)—*Anatom. Hefte*, 1919, LVII, 1. Abt., 582.

The author describes 48 new cases of supernumerary mammary glands. Most of them were situated near the normal nipples and more frequently below than above the latter. These accessory glands have been found in other locations, among which may be mentioned the abdomen (5 of the author's cases were on the latter), the back, the thigh, and the acromion. Supernumerary mammary glands occur hardly more frequently in women than in men; they are twice as frequent on the left as on the right side, and four times as frequent unilaterally as on both sides. They have been found to occur in successive generations and are most probably hereditary. Often these supernumerary glands are associated with other signs of degeneration, such as hypertrichosis, hernia, anomalies of teeth, and most frequently with more or less pronounced malformations of the ears.

A. H. SCHULTZ.

ZUR KENNTNIS SELTENER FAMILIÄRER MISSBILDUNGEN (Situs viscerum inversus. Trichterbrust). By Curschmann (H.)—*Anatom. Hefte*, 1919, LVII, 1. hbt., 402.

Description and discussion of cases of situs viscerum inversus and of funnel-chest. Both conditions are shown to occur at times repeatedly in the same family, a fact of importance in theories regarding their origin.

Situs viscerum inversus was found in the third and the fifth child of normal parents; both these children were left-handed. This is the first known case where situs inversus occurs in brother and sister, who were not twins. However, the author believes that this would not be found so rarely, if all members of a family, in which one case of situs inversus is known, were examined.

A true funnel-chest is always a congenital and not an acquired malformation. It is frequently found associated with other congenital anomalies, e.g., clubfoot. A number of new cases of funnel-chest are reported; in one, a very extreme case, the lower portion of the sternum touches the spine, thus dividing the thorax in two. Regarding the origin of these extreme cases the author agrees with a number of other authors that it is caused by a disproportion between the size of the uterine cavity and the fetus, thus pressing the chin of the fetus against its sternum, giving rise to a funnel-chest (?).

A. H. SCHULTZ.

THE OCCURRENCE OF CLUBBED FINGERS IN HEALTHY PERSONS AS A FAMILIAL PECULIARITY. By Weber (F. Parkes).—*Brit. Med. J.*, 1919, Sept. 20, p. 379.

Clubbing of the fingers is so well known as an acquired pathological condition, especially in connection with disease of the thoracic viscera, that its occasional occurrence in healthy persons as a familial (and doubtless also congenital) peculiarity deserves some attention. The author reports a congenital anomaly of this nature in three brothers, and mentions other cases, including one published.

EIN FALL DOMINANTER VERERBUNG VON SYNDACTYLIE. By Wolff (F.)—*Arch. f. Rassen- u. Gesellsch. Biologie*, 1918, XIII, 74.

Description of syndactylism in a white man, consisting of union of second and third toes and webbed third and fourth fingers. The syndactylism of toes was present in this man's father, in his three brothers and three sisters, in his three children, and in four sons of one of his brothers, as well as in a son of one of his sisters. The children of his other brothers and sisters were free of syndactylism, which is dominant in this family.

A. H. SCHULTZ.

AMERICAN INDIAN

SURGERY AMONG THE ANCIENT PERUVIANS. By MacCurdy (George Grant)—*Art and Archaeol.*, VII, No. 9, Dec., 1918.

Perhaps in no other part of the world was prehistoric trephining more in vogue than in Peru. Of the 273 skulls obtained from the highlands to the northwest of Cuzco in 1914 and 1915 by the Peruvian Expedition under the joint auspices of Yale University and the National Geographic Society, forty-seven were trephined. These included both male and female skulls. In thirteen of the skulls (of both sexes), trepanation followed fracture; in one, the operation was to remove diseased bone; in thirty-one, there were no visible signs of antecedent disease or wound; and in two, post-mortem decay made it impossible to determine whether there had been antecedent traumatism or disease of the bone. In eight cases, most of them involving fracture, death followed immediately; in eleven, there was partial healing; and in two, the degree of healing could not be determined. As practised among the ancient Peruvians, trepanation does not seem to have been a dangerous operation. The ratio of trephined to non-trephined skulls in this collection is greater (47 per cent) than that in any other collection hitherto described.

G. G. MACC.

NOTES

On the occasion of the recent (February 20-28, 1920) and largely attended Conference of the China Medical Missionary Association, in Peking, two steps were taken by those present which will have considerable bearing on the development of anthropological investigation in the Far East. The first was the formation of the Anatomical and Anthropological Association of China; the second a reconstruction of the Committee on Research of the China Medical Association. The new Association, under the chairmanship of Professor E. V. Cowdry, has begun activities with a good list of members and with a meeting which promises well for the future. The Research Committee of the China Medical Association, before departure from Peking, held several meetings during which definite tasks of research, medical and anthropological, were assigned to investigators in different parts of China. More extended report on these important steps will be forthcoming in the *China Medical Journal*.

NEW JOURNAL.—Under the name of "Ethnos," a new anthropological monthly has just been established in Mexico. The new journal is edited by Sr. Manuel Gamio, is printed on good paper in large octavo form, and is to serve all branches of Anthropology for Mexico and Central America. The first number, issued towards the end of May, brings in its 26 pages a number of interesting short articles, one of which, by P. S. Pauer, deals with the "Distribution of cephalic index in Mexico"; while another, by Sr. Gamio, describes the important "latest archeological discoveries in Teotihuacan." The establishment of a serial of this nature is a propitious sign for Mexican and Central American anthropology, and the *American Journal of Physical Anthropology* wishes the new periodical all possible success. The annual subscription for the new journal will be \$2.50 U. S. currency. The address is Ethnos, Apart. post. 10123, Mexico, D. F.

Dr. E. W. Gifford of the Department of Anthropology, University of California, and Mr. W. C. McKern, have been appointed research associates in Ethnology for one year on the staff of the Bishop Museum in Hawaii. Their field of operations is to be the Tonga group, and in their work they are to include research and collections in physical anthropology. Dr. Gifford, who is associate curator of the Museum of Anthropology of the University of California, has been granted a year's leave of absence for the above purpose. It is understood that Dr. Louis R. Sullivan, of the American Museum of Natural History, has recently also left for Hawaii where he will engage, in connection with the Bishop Museum, in anthropological work on the Hawaiians.

Dr. Albert E. Jenks, Professor of Anthropology at the University of Minnesota, has been elected President of the National Council of Americanization Workers at an organization meeting of Americanization Directors, Teachers, Supervisors, etc., held in Cleveland, Ohio, February 24 and 25. The first national meeting of the Council will be in Minneapolis, May 31 and June 1, 1920. In 1918, the University of Minnesota established the first scientific Training Course in the Americanization field. The course, which grants a B.S. degree, is under the directorship of Professor Jenks.

Dr. A. Hrdlička has returned from a journey to the Far East. He visited Japan, Korea, Manchuria, Northern China and the border of inner Mongolia. On the return a ten day stop was made at Hawaii for the purpose of some observation on the remnants of the native stock.

The National Research Council has elected the following officers for the year beginning July 1, 1920: Chairman, H. A. Bumstead, professor of physics and director of the Sloane physical laboratory, Yale University; First Vice-Chairman, C. D. Walcott, president of the National Academy of Sciences and Secretary of the Smithsonian Institution; Second Vice-Chairman, Gano Dunn, president of the J. G. White Engineering Corporation, New York; Third Vice-Chairman, R. A. Millikan, professor of physics, University of Chicago; permanent secretary, Vernon Kellogg, professor of biology, Stanford University; Treasurer F. L. Ransome, treasurer of the National Academy of Sciences. The Council was organized in 1916 under the auspices of the National Academy of Sciences to mobilize the scientific resources of America for work on war problems, and reorganized in 1918 by an executive order of the President on a permanent peace-time basis. Although cooperating with various government scientific bureaus it is not controlled or supported by the government. It has recently received an endowment of \$5,000,000 from the Carnegie Corporation, part of which is to be expended for the erection of a suitable building in Washington for the joint use of the Council and the National Academy of Sciences. Other gifts have been made to it for the carrying out of specific researches under its direction.

THE SPY SKELETONS.—Authentic information is now at hand that the Spy remains are safe. Before the war they were preserved in the Paleontological Museum of the University of Liege. They were still in these collections when Liege and the University were occupied by the Germans; but they were rescued by an employee who entered the Museum under the pretext of carrying bread to the janitor, and remained throughout the war in the care of one of the professors. They were searched for repeatedly by the Germans, who were finally told that one of the faculty took them for safe keeping either to England or to the United States.

It is learned from the daily press that the proposed operation to separate the Filipino twins, Lucio and Simplicio Godino (see Vol. II, No. 1 of this Journal), has been finally abandoned. The boys are attending school in Washington, under guardianship of Teodoro R. Yangco, the Philippine commissioner; it is said they appear normal in every way and are making rapid progress in their studies. The twelfth birthday of the twins was recently celebrated.

RIDOLFO LIVI.✕—The death is announced of Professor Ridolfo Livi, Docent of Anthropology at the University of Rome. Professor Livi was born in 1856, and has rendered anthropology a signal service through the publication of his extensive work on Military Anthropometry of Italy. He died in Florence on the 12th April of this year.

A. M. PATTERSON.✕—A belated number of the *Journal of Anatomy* (London) brings the news of the death of Dr. A. M. Patterson, since 1894 Professor of Anatomy at the University of Liverpool. Professor Patterson's work has been closely associated with and often directly contributory to Physical Anthropology. His publications in this line include the following:

- Notes on abnormalities, with special reference to the vertebral arteries. *Anat. and Physiol.*, 1884, VIII, 294-303.
- Anomalies in the skeleton of a negro. *Proc. Anat. Soc. Gt. Britain and Ireland*, 1903, February, XXII-XXIV.
- The human sacrum. *Sc. Trans. Roy. Dublin Soc.*, 1893-1896, 2 ser., v, 123-204, 6 plates.
- Suprasternal ossifications. *Proc. Anat. Soc. Gt. Brit. and Ire.*, 1901, Feb. 10.
- The sternum; its early development and ossification in man and mammals. *J. Anat. and Phys.*, 1901, XXXV, 21-32, 2 pl.
- Development of the sternum and shoulder girdle in mammals. *Brit. Med. J.*, 1902, II, 777.
- The development and morphology of the ear. *J. Laryngol.*, 1903, XVIII, 404-407.
- The human sternum. 4°, Liverpool, 1904, 10 pl.
- Two abnormal sterna in living subjects. *J. Anat. and Physiol.*, 1909, XLIII, 322-323.
- The child as an asset to the Empire. *Liverpool Med. Chir. J.*, 1911, XXXI, 235-253; also *Pediatrics*, N. Y., 1911, XXIII, 642-655.
- The form of the human stomach. *J. Anat. and Physiol.*, 1913, XLVII, 356-359.
- The position and form of the normal human stomach. *Brit. Med. J.*, 1913, I, 1205-1206.
- The skeleton of a recent case of Myositis ossificans. *Proc. Anat. Soc. Gt. Brit. and Ire.*, 1915, Jan., 3-5.

The Japanese have begun the publication of a magazine to be known as the "Tongwon," the express object of which is to "cultivate friendly feelings of Koreans towards Japanese, by proving that the two people have come from a common father, and that they are in consequence brother races." The periodical "is to be devoted to purely scientific researches, having in them no grain of political meaning. It is still

open to question whether or not Japanese and Koreans have a common lineal father, but Mr. Kato and his clique intend to start and follow their researches on the supposition that the two races are so connected, making it their aim to prove the validity of the theory of Japanese and Koreans being of the same race. If the contrary is proved as a result of the scientific researches we are to follow . . . we will at once discontinue the publication of the magazine."

The first copy of the magazine has reached the editor, and it would be interesting to refer to the "scientific researches" therein contained, but it is printed wholly in Japanese and Korean.

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AGE CHANGES IN THE PUBIC BONE

I. THE MALE WHITE PUBIS

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INTRODUCTION

Everyone who has investigated series of skeletons, whether collections of modern necropolis material or of archeological importance, has felt the great lack of data upon which some reliable estimate of individual age may be based. This same lack is felt also in cases of medico-legal importance and in those which come under the control of the coroner long after all superficial and currently utilized signs of precise age have disappeared through decay. We are able, by examination of diaphyso-epiphysial junctions to make a fairly accurate estimate of age up to the commencement of adult life. Again we are

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able to identify with some assurance the onset of senility. But for the vast proportion of skeletons or bodies examined, namely those between 25 and 55, we have no reliable criteria of age and can make only the most hazardous guess even after long experience because experience without accurate data can result only in a quite general "appreciation" of age.

The laws of Ohio permit the retention of material in the Anatomical Laboratory for an indefinite period and the Civic and Hospital connections of the Medical School and Anatomical Department render comparatively easy the accumulation of precise clinical data regarding most of the material used. In view then of the unusual opportunity offered for a study of osteology, we began, some eight years ago, to collect a series of skeletons with as full records as time and systematic organization permit. Naturally the outbreak of War, occurring just as our methods were becoming perfected, interfered considerably with the work. But with the return of the staff and the consequent rehabilitation of the laboratory during 1919 the investigation has now assumed its fullest proportions. Hence a few words as to organization may not be out of place.

Each cadaver upon arrival in the laboratory is weighed and has its anthropometric measurements recorded. Specimens of hair and skin for color determination and fuller investigation are secured from eleven typical areas. The family record is obtained from the City Hall archives and the clinical history from the Hospital files in every case where these are extant. After measurements of the vertebral column and pelvis have been taken in the recent state the entire skeleton is finally macerated and preserved by methods which need not here be entered into. The prepared skeleton, housed in its own box, is then passed on to the osteological library where every bone has marked upon it in Indian ink the admission number of the cadaver. Although time consuming this technical detail is essential, for the entire skeleton must be readily identifiable and kept intact. A short description of the skeleton is then made and the established age checked up with the bony features. The record is filed with the family, clinical and anthropometric data, together with all photographs which have been taken during the course of the work. Pathological features also are noted and filed. When the whole procedure has been carried out the skeleton is ready for any systematic study. In order to eliminate personal errors, all routine measurements and reports are made by a single individual. The total number of skeletons now prepared

and upon which data are filed is about 650 and increases at about the rate of 100 a year.

In systematic work of this kind numbers are essential and disappointment regarding records are not infrequent. Also complete breakdown of part of the work, such as the anthropometric investigation, could not be avoided during the later years of the War. Nevertheless the writer now feels in a position to produce data of sufficient exactitude to warrant publication, and the first effort will be to set forth the observations on age characters which this wealth of material permits.

The material consists of skeletons of male and female Whites, both American and foreign born, and of male and female Negroes. The majority of the latter are naturally not of full African descent but have a varying admixture of European blood, upon which admixture it is hoped the skin and hair samples will be found to have some bearing when these are fully investigated. Such skeletons are therefore referred to in our investigations as negro-hybrids.

SKELETAL AGE CHANGES IN GENERAL

In the investigation of large series of human skeletons various modifications of the bones are met with which hitherto have not been accurately checked up against the age. Many of these modifications which appear successively during adult age are on the border-line between the anatomical and the pathological. Some cannot be so regarded, but must be classed as purely anatomical changes. Those upon which attention has been concentrated so far and which therefore must be dealt with in the course of the more immediate studies are: condition of teeth; closure of cranial sutures, both ectocranial and endocranial; occurrence of lipping on limb bones; ossification of costal cartilages; spondylitis as distinct from arthritis of the vertebral column; and changes in bony texture. In addition it has been found that certain bone areas adjacent to joints show definite sequence of modification strictly associated with age. In the main this group consists of amphiarthroses, namely the symphysis pubis, the intercentral joints of the vertebral column, and the manubrio-gladiolar articulation. But to these must also be added the sterno-clavicular, sacro-iliac and possibly the costo-chondral and chondro-sternal joints. The plane between the bone and the articular cartilage of these joints displays features resembling in some degree those of the diaphyso-epiphysial plane, and it is upon this fact that the age changes resolve themselves.

Adjacent to these joints 'articular' epiphyses ossify incompletely, erratically or not at all. Of the series the sterno-clavicular area early removes itself from consideration through the fusion of the epiphysis at the sternal end of the clavicle with the shaft of the bone, while the manubrio-gladiolar articulation is so erratic as apparently to warrant no confidence. The intercentral joints of the vertebral column, and the pelvic articulation areas, on the other hand, are most important. Even after the last stragglers among the epiphyses, namely those of the spines and transverse processes of the vertebrae, the heads of the ribs, and the sternal end of the clavicle, have lost their identity through fusion, the line of union of the central epiphyses shows distinct independence from the vertebral body. And when the second of these also at last, in the early thirties, fails to register the individual's age, the symphysis pubis still retains its role of time marker. Indeed the symphysis tells its tale throughout life, although less clearly from forty years onward than at an earlier age.

It is this prime importance of the symphysis as an age indicator which calls for its description first of all the age features.

No individual part of the skeleton however is infallible, and the most accurate estimate of age can only be made after examination of the entire skeleton. In the ensuing pages cases will be noted in which the symphysis lags behind or runs ahead of the rest of the skeleton in its development. But these instances are comparatively rare and cannot vitiate the main contention of the paper. According to our experience the symphysis, once its changing features are properly understood, forms one of the most stable and satisfactory guides to the age of the individual. But it is a relatively delicate bone and is often missing in skeletons which have lain for centuries in the earth, or is so badly damaged as to be of no value in age estimation. Hence it is necessary also to cast about for other more durable bony features and check them up against the symphysis upon our dated material. The comparative value of the several age indicators will be appraised in a later publication. Meantime it is well to bear in mind that the skeleton does not become adult in the sense that it shows no further gross changes of form or texture, at the age of twenty-five. Just as its histological structure is ever changing, so also are the naked eye features of the skeleton undergoing constant metamorphosis.

AGE CHANGES IN THE PUBIC BONE

THE AGE FACTOR IN ANTHROPOLOGY

In most anthropological work the extreme difficulty of the age question scarcely obtrudes itself. The integument with its accessories, especially the hair, has been the feature most generally utilized in checking up the stated age of an individual. Though important, the skin does not act as a very sensitive time marker and hence there is usually no stimulus in the investigator's mind to question the stated age of the individual in front of him, unless a very pronounced discrepancy exists. In consequence the difficulty of getting precise and reliable data regarding age was greatly underestimated at the beginning of our skeletal investigation and this difficulty is responsible in larger degree than any other single circumstance for the long period between the inception of the Western Reserve University collection of skeletons and the publication of studies thereupon. It is not everyone who knows his own age, and some of those who do make erroneous statements regarding their age for various reasons; and with dissecting room material there are probably still other sources of misinformation.

When we came to deal with the material collected here our early impression was one of discouragement so far as age was concerned. In the first place we paid too much attention to the skull, the state of obliteration of the sutures of which we used as a time marker. The sutures, both ectocranial and endocranial, merit special consideration, but up to the present we have found them less constant in their age relationship than certain other features of the skeleton. Secondly we relied too much on official Municipal records. Only after the hospital files were thoroughly organized and rendered worthy of serious attention did we realize that the data which we were gathering in the laboratory were far more trustworthy than official documents. Of late years there has been great improvement in records and this source of error can be largely discounted. A third factor which caused us to doubt seriously our results is the irregularity of the age curve. This is well shown in the polygon of ages of the material at present under investigation (Chart 1.) Whereas the polygon under thirty years and over sixty exhibits what one might expect to be the natural irregularity, the startling upward leaps of the polygon at thirty-five, forty, forty-five, fifty and sixty years cannot be explained in any such manner. No interpretation involving a fatal periodicity is acceptable and one can only say that individuals must be included who have given their ages in round numbers. We therefore set to work to exclude as discredited all skeletons of these ages which did

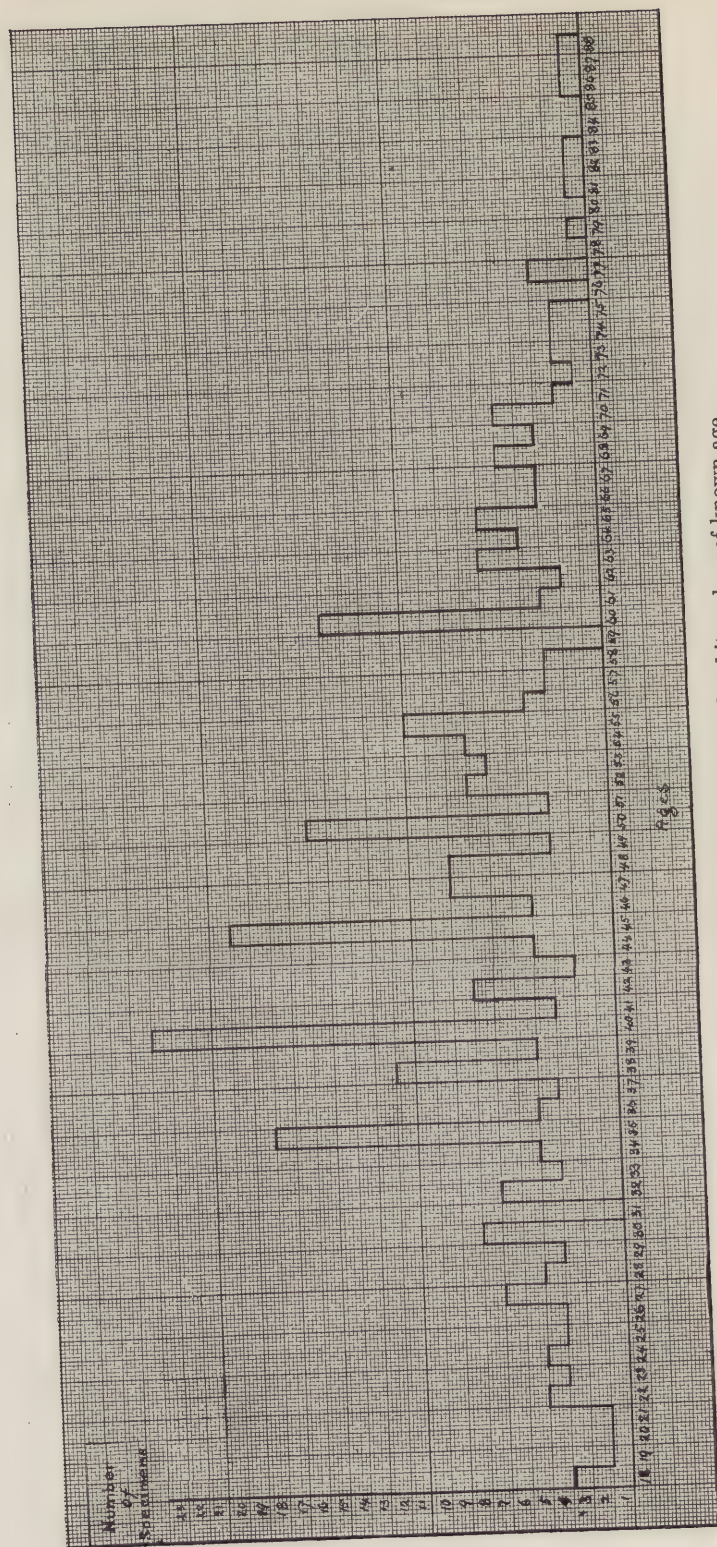


CHART 1. Polygon of age frequency—Male white pelvises of known age.

Note the remarkably large number of skeletons of ages 35, 40, 45, 50 and 60 years and the considerable number at 38 and 55 years compared with the relatively uniform number at all other ages. This is probably explained by a tendency of individuals to give their age in round numbers.

not show a fairly constant relation to the age characters which we came to adopt as standards. We then found that skeletons of other stated ages gave us just as much trouble, and further we observed that certain diseases and defects have a marked influence upon skeletal features. Microcephaly, various forms of insanity, syphilis and to a less extent tuberculosis, considerably increase the apparent age of the skeleton. Hypophysial tumors, disorders allied to achondroplasia, and rickets retard the skeletal age. These are but a few examples. So that once more we were led to doubt the reliability of our data. Working over the material afresh we found that there are two types of age change, and that our dilemma had been caused by the confusion of the two together. One may be regarded as the normal developmental progress of the skeleton, the other as that induced by external factors such as disease, habits and use. In this study of the pubis, for example, we shall find that there are certain phases of metamorphosis which the bone normally undergoes and that these phases may be passed through with regularity, but we shall also see that progress may be accelerated, retarded or possibly even inhibited at any stage. Then there are other phases which cannot be regarded as perfectly normal. They may be frankly pathological, some falling under the caption arthritis, but they also may lie upon the border-line between the normal and the pathological in the sense that they occur in every individual sooner or later. It was only when we had learned to differentiate between these types of age change that our confidence was restored.

As an example of our early difficulties, skeletons 107 and 708 may be cited (see Fig. 65). Both are of age thirty-two and both have hospital records. Nevertheless No. 107 was discarded at first because of lipping of joints and No. 708 because of changes in bone texture. Later investigation showed that both retained many characteristics of the stated age but these were obscured, except for careful search, by the features probably induced by disease (arthritis in No. 107, tuberculosis in No. 708). Consequently both were restored to the series of known age.

It must be remembered that in this work we had no standards to fall back upon. All so-called age changes hitherto utilized we found to be largely surmises based upon material inadequate in point of numbers and data to fulfil the purpose which it was made to serve.

Finally we realize the inadequacy of our own material so far as statistical survey is concerned, but we do hold that it is now large enough to form the nucleus upon which some real knowledge of age

changes may be founded. The conclusion to which we have come as regards records of age is, that in the present state of our knowledge it would be unwise to eliminate any of those skeletons whose ages are not called in question by gross and obvious contradictions in the bones. In spite of the expectation that eventually we shall sift out some of our material of supposed known age, we feel strongly that at present we must adopt the course of accepting the stated age. To decline to do this before our knowledge is much more perfect than it is at present is to invite the disaster which is bound to follow the retention of preconceived ideas. Until we can prove beyond shadow of a doubt that misstatements have been made regarding age, it is safer to accept the records, controlled as they are in various ways elsewhere enumerated. We can at least feel sure that subject to the limitations common to all humanity our age records are dependable.

GROSS CHANGES IN THE PUBIC BONE

I. HISTORICAL

That gross changes are undergone by the pubic bone during the life of an individual is by no means a new idea. Cleland in 1889 wrote as follows (1): "The distance between the lines marking the inner limit of attachment of the femoral muscles on the right and left sides is considerably greater in the female than in the male. In a middle-aged or old female the line in question will always be seen marked by a distinct ridge, with a flattened surface extending inwards from it, covered in the recent state by the superficial ligament of the symphysis; and the distance between the two ridges of opposite sides will be found to increase as the pubic arch is approached." This distinction, Cleland says, has great constancy and is to be depended on, *provided ossification is thoroughly completed* [italics T.W.T.]. "The weak point of the character is that it is difficult to apply in the young adult. . . . The os innominatum is complete at both of these places [iliac and ischial epiphyses] considerably earlier than at the symphysis." Irregular ossific nodules upon the symphyseal face of the pubis may be found distinct after the bone is everywhere else complete. "Probably ossification at this part is completed earlier in the male than in the female." Cleland obviously had a bias toward believing that the features, which I shall show to be age characters, are more distinctive of the female than the male and hence sex indicators. "Doubtless, also," he continues, "the body of the pubic bone continues to grow more rapidly towards the perineal border of the symphysis than at the abdominal border."

Following up statements by Litzmann and Matthews Duncan regarding changes in form of the pelvic brim, Cleland observes that until puberty both iliac and pubic parts of the brim can be lengthened by additions at their acetabular extremities, but that after the sutures of the acetabulum are obliterated, "the iliac part of the brim is incapable of elongation, while growth at the symphysis continues. . . till adult life." Apparently Cleland was unacquainted with the considerable amount of work already done upon the symphyseal face of the pubic bone, the changes in which, as I shall endeavor later to show, are bound up causally with the increased distance between the "limiting lines of the femoral muscles of right and left sides." He also gives undue importance to the amount of actual growth of the pubic bone, that is to say elongation in the line of the *linea arcuata*, which can occur at the symphyseal extremity after puberty.

Henle, in his *Handbuch der Bänderlehre* (1872), recognized that the symphyseal face of the pubic bone undergoes variation in dimensions and texture with age and he describes in the following manner the form which he regards as normal, since "it is most frequently presented in middle age and is an intermediate form between extremes" "Die elliptischen Flächen, welche beide Hüftbeine einander zuwenden, haben hyalinische Knorpelbekleidung von ansehnlicher und über die ganze Oberfläche ziemlich bliebender Mächtigkeit (2 bis 3Mm.). Sie sind im Frontalschnitt wellenförmig in Folge von Wülsten, welche mit grösserer oder geringerer Unterbrechung quer von hinten nach vorn über die Knochenfläche verlaufen und ohne Zweifel für die Festigkeit ihrer Verbindung mit dem Knorpel von Bedeutung sind. Zuweilen enthält der Knorpel isolirte Knochenkerne oder es finden sich Knorpelinseln, rings von Knochen umschlossen, der Oberfläche des letzteren (Aeby)."

Plainly Henle derived his information from Aeby's work as will shortly appear, although he did not clearly state the conclusions to which Aeby came.

The fact that the symphyseal face of the pubic bone is not the same in texture throughout life, did not escape Waldeyer's artist, although these features are not stressed by the author himself. Fig. 18 in Waldeyer's *Das Becken*, which shows the left side of the pelvis, is clearly that of a young woman eighteen to twenty years old, for the typical rugged surface of the symphyseal face is indicated although not very accurately drawn (3).

In most standard text books and figures the symphyseal face of the

pubis is accepted as an oval surface, smooth in character and outlined by a perfectly regular margin. This however is the case only in pubic bones of the age of about forty years and upwards until secondary changes begin to make their appearance at fifty or over. These facts are passed over even by Martin in his *Lehrbuch*, where directions are given for measuring the height of the bony symphysis without any indication that this can be done with accuracy only in pelves which have reached the age of 35 or thereabouts (4).

Quite the most important contribution to the subject was made in 1858 by Aeby (5) who, like the many authors who had previously written upon the pubic bone, was interested primarily in the ligaments and soft tissues of the symphysis itself. Aeby describes the symphyseal face of the pubis as a more or less irregular convex surface bounded by an oval outline, and of which the finer structural relations are largely lost in maceration. It is incorrect to assume, however, that the finer structural *features* are lost in maceration. The whole purpose of the present paper is to illustrate the constant change which these features undergo with increasing age. Apparently Aeby had no macerated material to work upon but was restricted to a comparatively small series of recent specimens which he studied by section. There is, of course no doubt that such a method permits most exact observations upon the fibro-cartilage in its relation to the bone and joint cavity, but for a complete study of the bony parts macerated material, the age of which is accurately known, is essential. The present paper therefore supplements and extends Aeby's observations as regards the bone. Aeby had sufficient material to enable him to see that marked changes are undergone by the bony symphyseal face with age, for he states as a general law that with the passing of childhood the variety and irregularity of its form increase, but that later in life it once more becomes a single smooth surface. Aeby notes that, seen in coronal section, the outline of the surface in childhood forms a low, moderately smoothly rounded line, but that later it indicates a surface on which are horizontally directed furrows and ridges, which he concluded are of importance in establishing firm union with the cartilage. This new formation Aeby observes was noted by Tenon in 1806 and occurs in its most pronounced form after puberty, when the ridges have a height of 2mm. Later the corrugated appearance diminishes, but does not entirely disappear even in advanced age. This last clause does not accurately represent the condition in later life, as will shortly be shown, although the entire sentence is a brief but adequate statement of the actual facts.

Aeby also observed age variation in the upper and lower extremities of the symphyseal face, but he rightly commends the comparison of horizontal sections as showing most clearly the age changes. The outline in horizontal section, he notes, is often highly regular and even semi-circular in childhood but very soon becomes changed by the tendency to form angles [that is, borders], dorsal and ventral to the symphyseal face. Of these the dorsal one forms first, and the ventral margin even elongates so that the symphyseal surfaces of right and left sides are obliquely inclined toward each other to form an angle open ventrally. From this various successive gradations occur until eventually the surfaces are parallel, and moreover these gradations have a constant relation to age, although the author does not hazard what this relation actually is. But, Aeby goes on to point out, the growth of the bony margin is not symmetrical and only exceptionally do the two sides correspond. Here he was misled by the exaggerated impression of asymmetry which a study by cross-section alone is bound to give. In the figures accompanying this paper it will be seen that in the main the bony development is in reality fairly symmetrical. Similarly Aeby noted the presence of bony islands or cartilaginous islands especially along the ventral margin. We shall see that these are the natural result, in some cases, of the method of formation of the ventral margin. These features were already described in 1777 by Bonn (6). Further Aeby observed two of the asymmetrical formations which we shall have to discuss, namely, that in which both symphyseal surfaces are curved towards the same side, and that where one symphyseal face is markedly smaller than the other.

Aeby's discussion of purely sexual features we must defer until the female symphysis is considered, but we may now observe that he recognized the fact that at puberty the symphyseal surface has practically reached its adult size. This is actually the case, but it must be remembered that Aeby was dealing with symphyses in the recent state and so measured the cartilage-covered surface. In our figures it is apparent that such measurements cannot be made upon the bone itself until the margins are definitely formed, that is to say until about the age of thirty to thirty-five years.

Aeby, being primarily interested in the soft parts was naturally eager to discover what occurs in these soft parts during pregnancy. He was strongly impressed with the vascular relations of the ligaments and indeed of the bones, had noted the occasional occurrence of inflammatory union of the two pubic bones described by Gurlt (7), though

Aeby himself had never seen such a case, and concluded that vascularity, or "periodic softening," is the cause of differences to be noted in the precise manner and speed of ossification between the sexes. This statement we shall discuss later but for the moment shall leave without comment.

To William Hunter belongs the credit of having observed the similarity between the symphysis pubis and the intercentral joints of the

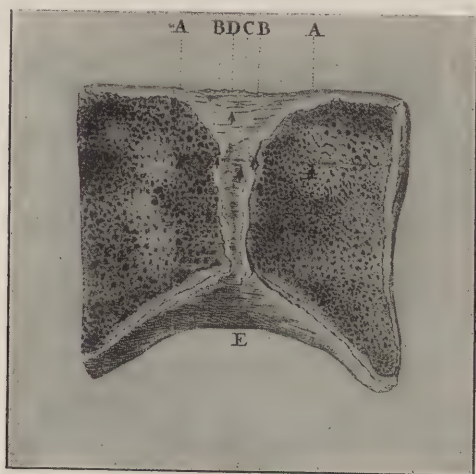


FIG. 1. A vertical section of the symphysis of the ossa pubis, in a female subject that had not been with child.

AA. The ossa pubis near the symphysis.

BB. The cartilaginous crust that covers and adheres to the surface of each bone at the symphysis.

C. The interior ligamentous substance, which connects the two gristles. It easily tears in the middle, upon bending such a preparation of the part as this; and, in dead bodies, it dissolves by putrefaction, much sooner than any other part of the joint.

D. The upper part of the symphysis, consisting of a strong ligament, which runs across from bone to bone.

E. A strong transverse ligament of the same kind at the lower part of the symphysis. (After William Hunter.)

vertebral column (13), a similarity which I find also in certain features of their bone change. Like Aeby and most others who have occupied themselves with the pubic symphysis, Hunter's attention was focussed upon changes in the soft tissues, but he certainly observed the lipping of the dorsal symphyseal margin which occurs in later years, and there

is equally no doubt from his figures here reproduced (Figs. 1, 2) that he was acquainted with the ventral beveling which occurs during the third decennium.

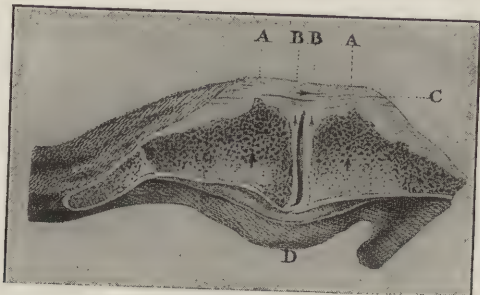


FIG. 2. An horizontal section of the symphysis of the ossa pubis in a subject who died of a fever in child-bed.

AA. The os pubis on each side of the symphysis.

BB. The cartilaginous crest that covers and adheres to the surface of each bone at the symphysis. The narrow dark space between these two cartilages represents the cavity of the joint, where the two cartilages played upon one another by loose surfaces when the ossa pubis were moved in different directions. These surfaces were not of a polished smoothness, as in most other joints; but a little unequal, as if they had been somewhat eroded. The ossa pubis were bound so firmly together that the surfaces of the two cartilages were kept close in contact; and upon drawing the bones from each other, when the section was made, they readily separated as far, and made such a cavity, as is represented in this figure.

C. The anterior transverse ligament of the joint which is blended with the tendinous fibres from the adjacent muscles.

D. The internal transverse ligament of the joint. In some subjects it is very thick and strong; and then it makes a considerable projection all down the inside of the symphysis, as in this figure. (After William Hunter.)

GROSS CHANGES IN THE PUBIC BONE

II. TECHNICAL METHODS

As regards technique of preparation and presentation of the data in this paper there is little to explain. First, however, it is necessary to point out that in no case are the features presented either brought about or influenced by the technique of preparation. The symphysial face, upon which our attention is largely concentrated, is a modified diaphyso-epiphysial plane and, as such, may be expected to show a metamorphosis if not actual growth as an age feature. It is one of the objects of this paper to distinguish between metamorphosis and growth at this site.



FIG. 3. Ossa innominata of specimen 571, male, white, age sixty-nine. Symphyseal face shows some erosion and therefore falls into phase 10. Note the well marked lipping of the attachment of the sacro-tuberous ligaments. The small rectangle shows the area represented in succeeding figures. The left os pubis is always to the left of the figure. The dorsal symphyseal margins are remote from each other.

The article is profusely illustrated for the following reasons. First it is intended to serve as part of a guide in identifying approximate age of skeletons for those investigators who are held back from work in osteology by lack of precise information regarding the age of their material. Secondly, only by the study of many specimens can one appreciate fully the importance of the age changes discussed and the slight individual variations which occur. Thirdly whereas most anatomical laboratories have a fair number of skeletons of later adult age ready for study, in consequence of which it has been necessary in this communication to present merely a few typical such examples, young adult skeletons are rare and a considerable number of figures has been included so that the student may enlarge his acquaintance with this material which is not so easily obtained.

The photographs were all taken natural size and are reduced in reproduction by one-half. One must not infer however that any dimension measured upon the illustration and multiplied by two will give the exact measurement on the bone, for the specimens have been photographed from somewhat different angles in order to bring out better the special features to which attention is directed. The shadows also have been arranged with this object in mind. Although the photographs may not be used for precise determination of dimensions they do give an indication of the relative individual variation in size of the symphyseal face. The orientation of the pubic bones can best be understood by reference to Fig. 3, which shows the two ossa innominata of specimen 571, a white male subject aged sixty-nine. The symphyseal face of the pubic bones shows the secondary excavation which I shall describe as phase 10. But the purpose of this figure is really to indicate, by means of the small inset rectangle which includes the pubic symphyseal area, what part of the bones is photographed in the illustration of this paper. It will be seen that the left pubis is on the left of each figure and the right bone on the right. Further, the ventral margins of the two bones are approximated whereas the dorsal margins are remote from each other. The bones are so arranged in order to bring the essential parts close together for photography and reproduction.

With regard to methods of pelvimetry, it has not been the intention at this stage to introduce tables of measurements and indices, but rather to deal with the morphological features first and in later communications discuss the measurements when these can be presented for both male and female, white and negro-hybrid together. Because of

their intimate relation to our studies, however, it has been necessary to employ certain measurements and the precise method employed is described each in its appropriate place. As I state later on in this paper, we have found the well-recognized measurement of pelvic height very unsatisfactory as a standard unit for the pelvis for reasons which I shall briefly outline. Naturally one would consider the matter very carefully before rejecting any anthropometric method with which so much work has been done as the total pelvic height. Full consideration of the matter would be beyond the scope of this paper but it will be necessary to explain shortly why I have chosen an altogether different standard for the symphysio-pelvic index.

Details of the measurement of symphysial height and of the height of the true (small) pelvis will be given in the appropriate section of a future paper. The methods followed by v.d. Broek (14, p. 12) could not be adopted. The lowest point of the tuber ischii, as he defines it, is not morphologically comparable on different human individuals or in Primates in general. Also the vertical measurement of the "rough surface" of the symphysial face is quite ambiguous especially in reference to age.

GROSS CHANGES IN THE PUBIC BONE

III. DESCRIPTIVE

In the series of 306 skeletons which forms the basis of this paper, it is to be noted that all are of the male sex and of White stock. Further we are concerned only with those changes which occur after puberty. We take therefore, as examples showing the condition of the pubic bone soon after puberty has been reached, skeletons 98 and 410 (Figs. 4, 5), both of stated age eighteen years, the age being confirmed by the characters of the entire skeleton in each case.

In both the epiphyses for the ischial tuberosities and for the iliac crests and anterior superior spines are merely commencing to unite with the main masses of bone. The epiphyses for the anterior inferior spines are already united on both sides in skeleton 98 and on the left side of 410. On the right side of 410 this epiphysis is incompletely united.

In both skeletons the symphysial face of the pubis presents a very striking appearance. It is traversed by ridges horizontally placed and separated by well marked grooves. In the upper part of the surface the ridges are more massive and traverse the entire breadth of the area; in the lower part they are smaller, are separated by shallower

grooves, do not pass across the entire surface and, on the contrary, tend to become confluent. In skeleton 98 the rugged symphyseal face extends as far as and includes the pubic tubercle, but in No. 410 this is not the case for the pubic tubercle is already completely ossified, apparently without the aid of an epiphysis.

Epiphyses upon the symphyseal face are erratic and very irregular. When they occur they form simply irregular bony masses or nodules fused with the upper or ventral part of the area. No such nodule occurs on the symphyseal face of either of these skeletons.

Equally distinctive of the phase of growth represented by these skeletons is the complete absence of a delimiting margin to the symphyseal face, which is nevertheless distinctly marked off from the ventral and dorsal aspects of the pubic bone by a sudden change in surface appearance and bony texture. A horizontal section through the pubis at right angles to the symphyseal face would show a sudden termination of the deeply furrowed cartilage covered area at its ventral and dorsal limits. In similar though less abrupt fashion the symphyseal area is delimited from the upper aspect of the pubic bone. The lower part of the surface, on the other hand, merges gradually into the smoother textured inferior pubic ramus. Thus we see that while the antero-posterior depth of the symphyseal face may be measured with a fair degree of assurance, it is quite impossible to determine accurately the vertical diameter.

Skeleton 233 (Fig. 6) is of age 19 and in general illustrates the features just described for specimens 98 and 410, but is obviously slightly older, the bony features corresponding with the stated age. The iliac crests are uniting and the ischial epiphyses are united to the tubera though not to the rami. Examination of the symphyseal face reveals no obvious change on the right side from the appearance noted in skeletons 98 and 410. On the left side of the pubis, however, there is slight indication of the formation of a ridge, which connects up the dorsal extremities of the horizontal furrows. This commencing delimiting dorsal margin becomes the most significant feature of the succeeding phase.

In brief then we may define the stage of ossification of the pubic bone in skeletons 98, 410 and 233 in the following manner:

First post-adolescent phase. Age 18-19. Symphyseal surface rugged, traversed by horizontal ridges separated by well marked grooves; no ossific (epiphysal) nodules fusing with the surface; no definite delimiting margin; no definition of extremities.

We turn now to Figs. 7, 8, which represent the symphyseal face of skeletons 583 and 248, and we note at once that the bone surface has lost to some extent the clear definition of its ridges, more so in No. 248 than in 583. This difference in appearance is distinct enough to indicate a step onward in the developmental process. No. 583 is of stated age twenty and No. 248 is of stated age twenty-one. In each case the condition of the skeleton confirms the age as given. In No. 583 the iliac crest epiphyses are almost united and show merely traces of the line of union. In No. 248 the iliac crests are entirely united and no vestige of the epiphyseal line remains. In both specimens the ischial epiphyses are still in process of uniting with the rami.

In accordance with this more advanced ossification of the os innominatum generally there are to be noted changes in the pubis. The ridge which was observed on the dorsal margin of the symphyseal face of No. 233, linking up the hinder extremities of the horizontal ridges, is already better marked in No. 583 and is quite distinctly seen in No. 248. More especially in the latter the grooves adjacent to this dorsal delimiting ridge are filling up with a finely textured bone which is even encroaching upon the hinder extremities of the horizontal ridges. No. 248 in addition shows a bony nodule fused to the upper part of the face of the left bone, corresponding to the ossification center of an epiphysis. As will be seen later, this nodule, though exhibited by many examples, is not invariably present. When it occurs it helps to form the upper delimitation of the symphyseal face, but this delimitation may occur equally well without the participation of the nodule in its formation.

Another feature begins to make its appearance during this period, although it cannot be said to be of much account until the succeeding stage is reached. This is a break-down of the ventral extremities of the ridges by rarefaction of the bony tissue affecting ridges and furrows alike and resulting in a distinct ventral bevel, seen very clearly in William Hunter's and Aeby's figures, and characteristic of post-adolescent stages. This will be appreciated better by noting the appearance of Figs. 7, 8, after observing the more pronounced condition shown in Figs. 9-16.

We may therefore summarize the appearance of the bone in these two specimens in the following manner:

Second post-adolescent phase—Age 20-21. Symphyseal surface still rugged, traversed by horizontal ridges, the grooves between which are, however, becoming filled near the dorsal limit with a new formation

of finely textured bone. This formation begins to obscure the hinder extremities of the horizontal ridges. Ossific (epiphysial) nodules fusing with the upper symphysial face may occur; dorsal limiting margin begins to develop; no delimitation of extremities; foreshadowing of ventral bevel.

The next stage in development is mainly one of progressive rarefaction resulting in ventral beveling of the symphysial face, and is illustrated by Figs. 9-16. These represent Nos. 503 of stated age twenty-two, 471, 680, 694, all of stated age twenty-three, 628, 423, 688 of age twenty-four, and 584 of stated age twenty-five. As regards general ossification of the *os innominatum*, we note that in Nos. 503, 471, and 628 there is incomplete union of the ischial epiphyses to the rami, although union has progressed much further in the case of the last two than in No. 503. Nos. 608 and 694 show complete union of this epiphysis.

In all, the symphysial face clearly shows ridges and furrows the filling up and obliteration of the dorsal ends of which become progressively better marked, although there is no rapid change in this feature as there is in the succeeding phase. As already mentioned, the most characteristic appearance of the 22-24 year period is the beveling of the ventral border so striking shown in No. 694.

The ventral extremities of the horizontal ridges and grooves are obliterated by the appearance of a rounded and very porous vertical strip of bone gently beveling the symphysial face into the ventral surface of the pubic body. This takes the place of the abrupt differentiation between these two aspects noted in the foregoing examples. We shall see that from this stage onwards the porous beveled strip becomes more pronounced, until it is finally obliterated by the superposition upon it of the definitive ventral margin. The porous beveled strip is very well shown in section by Hunter's figure (Fig. 2).

In all specimens, except No. 688, there is a bony nodule fusing with the upper symphysial face. The dorsal margin gradually progresses in its definition, but there is no indication as yet of the extremities.

In Nos. 680 and 694 the less pronounced degree of ridge and furrow formation is worthy of more than passing notice, since it introduces us to one the variants upon the typical condition. Shortly it will become obvious that the degree of development of these varies considerably in different individuals, and further, that there is a distinct tendency to progressive obliteration of the ridge and furrow system with advancing age. In this connection Nos. 423 and 688 are very

important. The former is an example of the variant in which the ridge and furrow system has, seemingly, never been very well defined, while in No. 688 it is rapidly becoming obliterated.

Specimen 423, of definitely ascertained age twenty-four, illustrates for us a type of bone which at first caused some confusion until it was recognized that the only real difference lay in the fact that in it there is a greater general tendency to smoothness of the symphyseal face. Accordingly the horizontal ridges and furrows upon this specimen are less pronounced, but the difference is one of degree only. The developing dorsal margin is present and the filling up of the hinder end of the furrows is also occurring, but these features are not so well-marked as in the more typical specimens, and at first sight seem to indicate that the growth processes have not progressed so far. The presence of a bony nodule at the upper end of each symphyseal face however contradicts this and there is no vestige of the line of union of the ischial epiphysis.

The beveling of the ventral margin is just as pronounced though not so obvious at first, as it is in the other specimens. Nos. 680 and 694 illustrate bones transitional in appearance between No. 423 and the typical form.

Nos. 688 and 584 show slight advances upon the other examples, for besides having a more clearly and completely defined dorsal margin they show the beginning of what one may call the dorsal plateau. In 688 the newly formed, finely textured bone adjacent to the dorsal margin has formed a narrow platform or plateau upon which the ridge and furrow system is obliterated. In this specimen the plateau is merely a narrow strip paralleling the dorsal margin.

In No. 584 the platform has increased throughout the length of the symphyseal face and extends across one third of its breadth. In general, however, No. 584 is not developed so far as our other specimens of age twenty-five and hence it is included in the group of age twenty-two to twenty-four. We therefore summarize the foregoing features thus:

Third post-adolescent phase. Age 22-24. Symphyseal face shows progressive obliteration of ridge and furrow system; commencing formation of the dorsal plateau; presence of fusing ossific (epiphyseal) nodules; dorsal margin gradually becoming more defined; beveling as a result of ventral rarefaction becoming rapidly more pronounced; no delimitation of extremities.

Ages twenty-five and twenty-six see another important change

occurring in the pubic bone, namely the beginning of delimitation of the lower symphyseal extremity. Figs. 17-20 illustrate the development of this phase. They represent pelves Nos. 575 of age twenty-five, 643, 424 and 490 of age twenty-six. The last mentioned introduces us to the succeeding phase in which delimitation of the upper extremity occurs.

In general one may say that this series, all of which except No. 424 show evidence of fusing bony nodules on the upper part of the symphyseal face, exhibit a progression resulting in a remodelling of the symphysis. The horizontal ridges and furrows of an earlier age are absent or reduced to mere vestiges, and their place taken by a more or less uniform bony surface, much beveled and rarefied toward the ventral margin, and showing more or less of a denser-textured dorsal plateau immediately adjoining the dorsal limiting border. The dorsal plateau shows practically no increase in area beyond that of the preceding phase. It is the rapid advancement of the ventral porous beveled strip which has encroached upon and so largely eliminated the ridge and furrow system. Nevertheless it is during this phase, with the definite appearance of the dorsal plateau, that one may consider the dorsal limiting margin really completed.

The other feature which characterizes this phase is the development of the lower extremity. The beginning of definition is seen in No. 575. In the succeeding specimens the definition becomes progressively clearer.

The border line case No. 490, in addition to showing some indication of the upper extremity, also exhibits a small accessory nodule of bone about the mid-vertical point of the symphyseal face towards the ventral aspect of the pubis. This is really a sporadic foreshadowing of the formation of the ventral rampart which will be described later.

Summarizing the changes just mentioned we can construct the following tabulation:

Fourth phase—Age 25-26. Great increase of ventral beveled area; corresponding diminution of ridge and furrow formation; complete definition of dorsal margin through the formation of the dorsal plateau; commencing delimitation of lower extremity.

Following rapidly upon the definition of the lower extremity is the delimitation of the upper extremity of the symphyseal face, which forms the main feature of the next phase including skeletons from twenty-seven to thirty years of age. These are shown in Figs. 21-30, comprising Nos. 614, 341, 672 and 287, of age twenty-seven, 251,

and 215 of age twenty-eight, 288 and 712 of age twenty-nine, and 142, with 623 of age thirty. From now on it is to be observed that the regular sequence of age, hitherto noted, no longer holds so efficiently, partly because of natural individual variation, partly because of the increasing tendency in the late twenties and still more in the thirties for the bone to cease metamorphosing and retain an incompletely appearance. But this is a problem which will bear fuller investigation after we have studied the age-type specimens and we shall therefore pass on to describe briefly the characters of the series.

The symphysial face itself undergoes but little change. The dorsal plateau in most cases remains the same narrow platform that grew up about the age of twenty-five; in some it is broader than in others.

Sporadically, and very clearly in No. 142, the ridge and furrow system remains but is no longer a significant feature of the bone. In many but not in all there is present a bony nodule in the upper part of the surface. In No. 142 there is a possible retardation of metamorphosis, but having examined the entire skeleton we may be sure that retardation in general did not occur to any marked extent and if present it had not been of more than two or three years' duration.

The most significant change in this phase is the formation of the upper extremity. In some instances it is developed by the aid of a bony (epiphysial) nodule, but specimens 288, 712 and 142 (Figs. 27-29) show that it can be formed equally well without the intervention of the "epiphysis." We therefore summarize the phase in the following manner.

Fifth phase—Age 27-30. Little or no change in symphysial face and dorsal plateau except that sporadic and premature attempts at the formation of a ventral rampart occur; lower extremity, like the dorsal margin, is increasing in clearness of definition; commencing formation of upper extremity with or without the intervention of a bony (epiphysial) nodule.

The next stage in development of the pubis is very distinctly more difficult to appraise correctly than those which have gone before, but its essential feature is the completion or approximate completion of the oval outline of the symphysial face. The difficulties of interpretation result from several factors. In the first place there seems to be a greater individual variation than at younger ages; that is, the remainder of the developmental process may be hurried up or delayed more than the earlier phases. Secondly, the terminal phases

are more difficult to examine because they affect relatively minor details. Thirdly, there is a distinct tendency for the terminal phase to be cut short so that the typical adult form of symphysis is never attained. Fortunately at the age when examination of the symphysis uncontrolled by other observations on the pelvis begins to fail in its reliability, distinct age changes occur in other parts of the os innominatum, so that actually the age characters of the pubis never lose their value. Before taking up this further and more complex problem we shall study the features of the pubis between thirty and thirty-five years of age. These are illustrated by Figs. 31-44 which represent pelvises nos. 238, 65, and 360 of stated age thirty; nos. 78 and 635 of age thirty two; nos. 671, 193 and 289 of age thirty three; nos. 342 and 301 of age thirty four; nos. 305, 104, 242 and 262 of age thirty five.

The two outstanding features of this series are the increasing definition of the extremities of the symphyseal face and the formation of the ventral rampart.

As regards the former, it will be noted that the lower extremity varies in its distinctness and sharpness of outline according to the individual: in some specimens it is much more clearly defined than in others of the same age. Nevertheless it is certainly formed in all of the series.

The case of the upper extremity is somewhat different. Even if a bony "epiphysal" nodule entered into its formation little or no trace of the "epiphysis" now remains. The upper extremity is much more uncertain in its formation than the lower. It may be almost entirely absent, but in no instance have I found so little of it that I was unable to state precisely what was its definite limit. No longer is it impossible, as was the case in specimens of the decade below thirty years, to state with assurance the vertical diameter of the symphyseal face.

The method of completion of the oval symphyseal outline by the building up of the ventral margin is most interesting. Already in several earlier specimens a sporadic effort to commence this border by an outgrowth from the lower extremity has been observed. Also there have been indications of a downgrowth from the upper extremity, although this is less constant and more erratic in its behavior when it occurs. I have pointed out in the case of Nos. 215 and 341 that intermediate tubercles of bone occur between these outgrowths. In this series we may see for the first time the precise role which each of these three factors plays in completion of the oval outline. The ventral margin differs from the dorsal border and from the extremities

in that it is not simply a gradual addition of bone to a basis already present: it is entirely a new formation—a rampart built up on the obliquely beveled ventral rarefied or porous area of the symphyseal face. Specimens 360 and 104 are the most instructive in showing the typical formation of this rampart, which is the result of linkage between the ventral prolongations of upper and lower extremities through new bone formation which may or may not be assisted by the presence of intermediate ossific nodules. In this process veritable bony bridges are formed and may be seen in many cases, a feature which attracted Aeby's attention. The development of the ventral rampart carries with it no formation of an adjoining plateau as does the dorsal margin, but the obliquely beveled ventral strip remains the same, and on both the symphyseal and ventral aspects of the rampart the original rarefied bony surface remains. It is only in later phases that this "granular" appearance of the symphyseal face and of the ventral aspect of the pubis becomes altered into a finer and more condensed bone.

It is not always, however, that the ventral rampart is formed in this typical manner. Oftentimes it gradually forms as in Nos. 238 and 78 by an obscure addition of bony tissue which is not sharply defined from the adjacent bone surface.

The ventral rampart is often incomplete. In Nos. 242 and 262 it has developed probably as completely as it ever would in these specimens. When a hiatus remains it is almost always in the upper third of the margin, as though the prolongation from the upper extremity had been too weak to complete its union with the upward growth from below.

Because of the variability in distinctness of the lower extremity and the uncertainty of completion of the ventral rampart, one cannot say that either of these features is more important as an age indicator. But by weighing together the amount of completion of the rampart and the definiteness of the extremities one may come to a fair estimate of the actual age, especially if these observations be checked up by the fact that in no case is there on the symphyseal margins the lipping which is a distinct feature of older bones.

The summary of age changes just discussed is the following:

Sixth phase—Age 30–35. Increasing definition of extremities; development and practical completion of ventral rampart; retention of granular appearance of symphyseal face and ventral aspect of pubis; absence of lipping of symphyseal margin.

We pass now to a phase of development starting at about thirty-five years and continuing to an uncertain upper limit, which, for the sake of definition, may be stated as about thirty-nine. In this phase the paramount feature is a gradual change in the symphyseal face and also the ventral aspect of the pubis from a granular texture to a more finely grained or dense bone, so that in many cases by thirty-eight years, and usually at forty, the symphyseal face resembles the typical appearance figured in anatomical textbooks. As examples Figs. 45-51 are given representing the following: No. 181 of stated age thirty-seven (left only); nos. 321, 647, and 481 of age thirty-eight; no. 112 of age thirty nine; and no. 196 of age forty.

The variation in final condition of the ventral rampart in different individuals is well seen in this series. In all cases the extremities, especially the lower, are clearly defined and indeed the lower extremity is already forming with the dorsal and ventral margin part of a "rim" for the symphyseal face. A little close observation of these figures enables one to realize when to discard the ventral rampart as an age indicator. It is incomplete on many of the bones and yet, from the changes going on in the symphyseal face proper, it is clear that the rampart has reached its fullest degree of completion *for that individual*. This interpretation is confirmed by a study of the older bones to the consideration of which we shall shortly pass.

The changes in the symphyseal face are quite obvious in the illustrations. The granular surface is giving place to a more finely textured bone on which may be seen, in some instances, remnants of the old ridge and furrow formation. But again as in the case of ventral rampart, this may not go on to completion. Nos. 112 and 196 are examples of aborted change, and that such interpretation is correct is evidenced by the fact that a further phase is already setting in, namely that of lipping of the symphyseal borders. This lipping is not pathological, or at least it is not distinctly so. It is better defined as the ossification which occurs in tendinous and ligamentous attachments to bone after the age of thirty-five years. Full discussion of the problem of lipping must be deferred as beyond the range of the present paper, but it is necessary to dwell upon it shortly in its relation to age changes in the pubis.

I have already mentioned that, taken alone, the pubis is less reliable as an age indicator in the decennium beyond thirty years than it was for younger bones. Now appears this new feature of lipping to assist in the diagnosis.

Usually before there is the slightest lipping of the symphyseal margins the attachment of the sacro-tuberous ligament begins to show an osteophytic growth which is sufficiently definite and constant in relation to age as to warrant use as an age indicator. This particular formation never occurs, in our experience, before the age of thirty-five years, and after that it progressively increases until certain dimensions and a well defined coarseness of structure are attained. The form which the lipping usually takes at the age of thirty-eight is shown in Fig. 46. This is specimen No. 647, the symphyseal face of which is illustrated for comparison in Fig. 45.

It is at this stage also that there appears the marked differentiation between the ventral rampart and the pubis proper, through the outgrowth of bony tissue into the line of attachment of the gracilis muscle (Frazer, 12). This is the feature which struck Cleland's attention and was described by him as "the line marking the inner limit of attachment of the femoral muscles." Cleland's views have been referred to rather fully in the historical part of this paper and further discussion will be reserved until we consider in detail the view he expressed regarding growth of the pelvic brim in the symphyseal area.

We may thus summarize the features of the pubis just given:

Seventh phase—Age 35–39. Changes in symphyseal face and ventral aspect of pubis consequent upon diminishing activity; commencing bony outgrowth into attachments of tendons and ligaments, especially the gracilis tendon and sacro-tuberous ligament.

We have just seen that pelves 112 and 196 of ages thirty-nine and forty, respectively, show commencing lipping of the symphyseal margins. This feature becomes of greater importance from now onward although it is still about five years before the lipping increases sufficiently to be generally of diagnostic importance. The bones of age greater than thirty-eight resolve themselves into three series, but much less accurately than those of the foregoing groups. Nevertheless we may state the approximate ages of the series next to be considered as thirty nine to forty-four. The main characteristic of this series is the general quiescence of the symphyseal surface accompanied by a similar quiescence of the ventral aspect. This inactivity is indicated by a smoothness of texture specially evinced by the symphyseal face. The rough, granular or pitted ventral aspect attains smoothness more slowly, but in typical bones of this period both surfaces are smooth and typical of text-book illustrations. A fair example of this phase is shown in Fig. 52, which is a photograph from specimen 314 of age

forty-two. There is a general smoothness of texture compared with previous figures. The oval outline is apparent if not very well defined, and the extremities are distinctly delimited. There is no pronounced lipping of the margins, the linear prominence appearing on the ventral aspect being in reality the line of attachment of the gracilis muscle, so greatly emphasized by Cleland as *the limit of attachment of the femoral muscles*. For a full statement of the number of specimens upon which this description and appreciation is based the reader is referred to the appendix. The features may however be summarized in the following manner:

Eighth phase—Age 39–44. Symphyseal face generally smooth and inactive; ventral surface of pubis also inactive; oval outline complete or approximately complete; extremities clearly defined; no distinct “rim” to symphyseal face; no marked lipping of either dorsal or ventral margin.

At approximately the age of forty-five, a new phase of the pubis appears, characterized by a well marked “rim” to the symphyseal face, and in most instances by some lipping of both dorsal and ventral margins. Again, as in the last series, a full statement of numbers will be obtained from the appendix. As fairly typical examples we have chosen specimens 202, and 325 of ages fifty-two and fifty-three respectively (Figs. 53, 54). The photographs of these specimens are almost too good, for every irregularity in the surface is emphasized so that the general impression of relative smoothness of the surface is diminished. Indeed it is difficult in these as in many specimens to deny that there is indication of the succeeding phase 10. They show the outstanding features of the present phase 9 so well, however, that one could not fail to include them in an article in which it is desired to stress specially the salient points.

No. 202 shows the rim but no marked lipping. The rim is formed by the ventral rampart and by a similar narrow marginal projection developing upon the extremities and dorsal margin, comparable to but more distinct than the bony rim which develops round the glenoid fossa on the scapula.

In No. 325 the rim is not so distinct, but the lipping of the ventral margin is so pronounced that no lengthy description is required. It will suffice to observe that the lipping consists of an irregular, somewhat moniliform series of rounded projections developing upon the ventral aspect of the ventral rampart. The dorsal lipping is much more uniform and is practically an intensification of the edge of bone.

When either of these features is present in well marked degree the specimen may be allocated to this group with assurance. Many times, however, it is difficult to say whether a specimen should be classed in phase 8 or phase 9 because the lipping or the rim formation is so slight, but when in doubt concerning the phase one is justified in estimating the specimen at approximately the border line age, which in the case of the present series would be about forty-five.

The features of this series are, briefly the following:

Ninth phase—Age 45-50. Symphysial face presents a more or less marked rim; dorsal margin uniformly lipped; ventral margin irregularly lipped.

Commencing as early in occasional cases as age forty-eight but in general approximately at fifty, further changes occur in the pubis, the result possibly of pathological conditions. One has doubts about speaking of the features themselves as pathological although in some instances they probably are. The condition is one of rarefaction of the symphysial face accompanied usually by irregular ossification, so that very bizarre types of symphysis are ultimately developed. The process starts in one of two ways. Rarefaction takes place first either in the symphysial face itself, or along the ventral margin, in which case it usually begins in the upper third, especially if the ventral margin has never been fully completed.

Fig. 55 is a photograph of specimen 382 (age 50) showing rarefaction of the entire symphysial face, but this is quite early and the rim of phase 9 can easily be seen at the lower extremity of the left bone. The upper third of the ventral margin is very markedly eroded and from this the advancing rarefaction can be seen encroaching on the symphysial face.

Pelvis No. 547 of age fifty-three, illustrated in Fig. 56, stands in contrast with the last and represents the other type of bone. Here, although there is destruction of the ventral margin to some extent, the major erosion is in the symphysial face itself. In neither this nor the former case has phase 9 shown any very marked lipping of the ventral margin.

From these specimens one passes to consider more pronounced types. Fig. 57 from specimen 253 of age 58 is a well marked case of erosion deeply excavating the symphysial face and bringing about entire collapse of the ventral margin. Even in the midst of this wreckage of the symphysis, however, a remnant of the rim of phase 9 still persists in the dorsal margin and extremities. This is not so in No. 359 of age

sixty-three and represented in Fig. 58. Here the entire area is completely transformed into an irregularly pitted surface.

It is to be noted that from fifty years onward these secondary changes resulting in breaking down of the symphyseal face increase in amount, and affect a greater proportion of individuals, until, as shown in the appendix, after the age sixty they are very frequent, and beyond seventy almost constant.

This is not the place to discuss the possible pathological nature of the secondary changes. The writer hopes at a later date to take up fully the senile features of the pelvis and this question properly belongs to that discussion. One can say, however, that they always commence in one of two ways, that they bear a more or less definite relation to age, that they are not associated with any definite disease of the bones which gives recognizable symptoms, and that the features of clinical lesions of the symphysis differ quite markedly from these.

The distinguishing characteristics of this period may be expressed thus:

Tenth phase—Age 50 and upward. Symphyseal face eroded and showing erratic ossification; ventral border more or less broken down; disfigurement increases with age.

It will be observed from the foregoing description that the pubic bone is a much more reliable age indicator from twenty years to forty than after the latter age. Nevertheless taken in conjunction with other pelvic features it is an important time marker even in later life. One may tabulate the chief periods as regards the pubic bone very shortly and simply and the table will permit a close approximation to the actual age when taken in conjunction with other features of the pelvis. A short statement of the pubic age changes was published in my preliminary abstract in the *Anatomical Record* (8). This may now be amplified and amended for male white skeletons as follows:

Phase 1.—Age 18-19. Typical adolescent ridge and furrow formation with no sign of margins and no ventral beveling.

Phase 2.—Age 20-21. Foreshadowing of ventral beveling with slight indication of dorsal margin.

Phase 3.—Age 22-24. Progressive obliteration of ridge and furrow system with increasing definition of dorsal margin and commencement of ventral rarefaction (beveling).

Phase 4.—Age 25-26. Completion of definite dorsal margin, rapid increase of ventral rarefaction and commencing delimitation of lower extremity.

Phase 5.—Age 27–30.* Commencing formation of upper extremity with increasing definition of lower extremity and possibly sporadic attempts at formation of ventral rampart.

Phase 6.—Age 30–35. Development and practical completion of ventral rampart with increasing definition of extremities.

Phase 7.—Age 35–39. Changes in symphyseal face and ventral aspect of pubis consequent upon diminishing activity, accompanied by bony outgrowths into pelvic attachments of tendons and ligaments.

Phase 8.—Age 39–44. Smoothness and inactivity of symphyseal face and ventral aspect of pubis. Oval outline and extremities clearly defined but no “rim” formation or lipping.

Phase 9.—Age 45–50. Development of “rim” on symphyseal face with lipping of dorsal and ventral margins.

Phase 10.—Age 50 and upwards. Erosion of and erratic, possibly pathological osteophytic growth on symphyseal face with breaking down of ventral margin.

The accuracy with which one may estimate age by means of the pubis was brought out very clearly in many of the specimens upon which this work is based, although no claim is made that there is any justification for using the pubis alone as an age indicator in case the entire skeleton is available for study. In the introduction it was mentioned that our files are completed by reference to City Hall records and Hospital case books. Our technique in the skeletal investigation is the following: After a survey of the entire skeleton the age is estimated by the investigator. Then the estimated age of the cadaver when first brought into the Department is produced. These two estimates are checked up with each other and with the City file. Lastly reference is made to the Hospital case book. The entire proceeding takes only a few minutes as all the records are at hand in the laboratory. We have observed, first as regards those bodies received during the few months after a political reorganization of the municipal Administration when the City Hall files were, in consequence, less accurately kept, and secondly in the case of those bodies received during the great influenza epidemic of 1918, when, by reason of the chaos inevitably resulting the City files were again less reliable, that the laboratory estimate was often at variance by several years with the City Hall statements. Practically always, in such cases, our experience has been that the Hospital case sheets have confirmed the laboratory estimate of age within two or three years up to 40 and to within five years beyond this age. In these laboratory estimates the pubic bone played an important but not the only part.

So far we have considered only specimens exemplifying what may be termed the typical progress in development of the pubis both as regards time and manner. One would not expect all pelves to fall into line with this classification. Hence we now turn to the consideration of pubic bones which show some apparent or real departure from the regular order; but upon the factors at work in controlling development of the os pubis very little light can as yet be shed.

Usually the outline of the symphyseal face is an elongated oval, but, as discussed in another section of this memoir, the index of the surface varies because of increase in breadth in the decennia following completion of the ventral rampart. There is a rare type of symphysis, however, in which the vertical height is very small. This occurs once only in the present series, namely in No. 94 (Fig. 59). The height of the symphyseal face of this individual is 22 mm. and his age twenty eight. Actually the specimen is at phase 8, but according to age it should be phase 5. There has therefore been in No. 94 some speeding up of the development of the symphysis which is at least correlated with the anomaly in form. From the photograph one can see very clearly the size which the symphyseal face should have attained to be normal.

The next group of anomalous cases to be studied is represented by Figs. 61-66 inclusive. These are examples of mixed phases, the development of the pubis having advanced more rapidly and also more irregularly than is usually the case. In all these specimens the general skeletal age is somewhat greater than the stated age. In the first three (Nos. 649-age twenty-two, 667-age twenty-four, 267-age twenty-five), there are sufficient indications to prevent the experienced observer from classifying them in too high a phase. In the first place none shows lipping of the ligamentous attachments to the tuber ischii. In Nos. 649 and 667 the commencing formation of the extremities and even changes in the surface should not obscure the observation that the dorsal margin is as yet just forming. These examples then combine features of phases 3 and 5.

No. 267 of age twenty-five in like manner shows a mixture of phases 4 and 6. The dorsal margin is only just completed, and the dorsal plateau has not yet attained any appreciable breadth. The views of this specimen given in Figs. 62, 63 show very well the amount of bony tissue added to the symphyseal face by the development of the ventral rampart and extremities after the ventral beveling has been completed.

Fig. 65, representing the symphyseal face of No. 708, shows a rather anomalous phase 7. This individual died at age thirty-two with tubercular left hip, after old Pott's disease of the spine. All his bones show the texture and many characteristics of a man of fifty, yet I hesitate to invoke the inflammatory vascularity of the parts as causative. This vascularity and Aeby's inferences therefrom we can discuss to better advantage in a later contribution which will deal with the female pubis. No. 708 then shows changes in the symphyseal face comparable with those usually noted between thirty-five and thirty-eight years of age.

The last example which we shall take of age changes in the pubis in advance of the actual years, is No. 68, illustrated in Fig. 66 and of age thirty-five. The features are those of phase 7, but they are obscured by the lipping of dorsal and ventral borders which we have seen to characterize phase 9. The man was a chronic alcoholic and eventually died of alcoholism. It may be that the exposure and irregularities connected with his habit are correlated with this lipping which is so unusual at this age.

We now glance at some of the cases showing retarded development of the pubis. For data as to the total number the reader is referred, as in the case of advanced specimens, to the classification of phases (pp. 328-9). A few illustrative types only are chosen.

No. 317 of age twenty-seven, Fig. 67, was a rachitic dwarf, who showed an extreme degree of kyphosis as well as other anomalies many of which certainly occurred as the result of retarded development. The dorsal margin is still in process of formation and the ventral beveling is still only poorly marked: hence the specimen falls into phase 3 and is retarded in development about four years.

No. 307 (Fig. 68) is a marked case of retardation. Though of age thirty-five the pubis shows features which cannot be classified as later than the border line between phases 5 and 6. There is nothing in the clinical record which seems to have bearing upon causation. In this specimen the pubis alone of all the skeleton is retarded in development.

No. 176 (Fig. 60), of age thirty-nine, on the contrary has clear indications of what brought about the retardation. This individual, whose pubis cannot be classified higher than phase 1, possessed in life a glabrous skin, eunuchoid features and infantile genitalia. The entire skeleton retained the condition usually attained at seventeen years, so far as epiphyses and other accepted indications of skeletal

age are concerned. A large osteoma was present in the sella turcica. So important is this specimen in its relation to bone development that a special study is being made of it. As regards the symphyseal face, the surface shows no ridge and furrow system it is true, but we have seen that even in normal cases this becomes obscured and frequently entirely obliterated, that the obscuring process sets in at about twenty-five years, and that an entirely new texture of the symphyseal face develops between thirty-five and thirty-eight years. Hence it is not astonishing that No. 176 has lost its ridge and furrow formation. The really important feature is the failure of any margin to develop. The consequent retention of phase 1 by this specimen, that is a phase in which there is still some slight actual growth at the symphysis, has resulted in a pubic-arcuate index of 61, which is greatly beyond that of other specimens of like phase.

Fig. 69 illustrates No. 185, of age forty, which is an important type and should be compared with Fig. 41 (No. 305) and later with Fig. 72 (No. 464). It is a specimen of delayed development and belongs to phase 7. The age suggested by the symphysis is thirty-five but the rest of the skeleton agrees quite well with the stated age forty. This is a genuine retardation without supervision of any of the changes which are characteristic of forty years.

The three specimens still to be considered illustrate mixed phases; but in these there is supervision of the phase more or less normal for the age upon a pubis of retarded development.

No. 210, of age forty-eight and illustrated in Fig. 70, shows the attempt of phase 8 to supervene upon phase 6. Obviously the ventral rampart in this bone has never developed and equally obviously there is a glossing over of the surface as formed, a kind of forced inactivity which has settled upon the bone and resulted in a somewhat wax-like appearance in place of the granular surface characteristic of phase 6.

No. 26 of age forty (Fig. 71), is from a skeleton the bone age of which, like the pubis in particular, indicates an age of about thirty-five years. But here as in No. 68 Fig. 66 there is a lipping more associated with phase 9. The supervision of phase 9 upon phase 6 in this case is also indicated by the formation of the symphyseal "rim" so well seen on the left bone.

The last atypical example to which reference will be directed in this review is No. 464 (Fig. 72), of age sixty-five. In my first examination of pelvis I classified this as phase 6, which indeed it is. But I failed at that time to recognize the very heavy lipping which is a feature of

the inferior pubic rami and other parts of the ossa innominata. I also failed to distinguish the secondary breakdown which is so well seen at the upper part of both symphyseal faces, especially the left, and results in erosion of ventral rampart and symphyseal face alike. The specimen is actually one of phase 10 supervening upon phase 6.

Before closing this section something should be said about frequency of retardations and advanced stages in relation to age, for it is the custom to reduce such observations to mathematical statements. In the present studies I maintain that such reductions are of little or no value. We have in this survey examined somewhat more than three hundred skeletons the majority of which are between thirty and sixty years of age. It is true that more than three hundred others have also been studied and must find their place in later communications. But admitting the entire series of between six and seven hundred, we have a very small number for any statistical study. Further the skeletons are random samples of very heterogeneous population, and thus the mathematical error stands to be very large.

One can state with assurance that types and phases here describe do occur and that their relation to age as shown by our material is approximately as I have tabulated it. Only by the addition of many more to this series and by constant checking, can one acquire sufficient data to make mathematical observations really worth while. To this paper is added an appendix giving the observations as regards phase and other relevant data. This appendix is intended to serve as the basis for further work, more especially upon this permanent material and by other workers who may desire to reinvestigate the views upon bone change here put forward. To this appendix I must for the present refer those who are interested in frequencies.

It does not appear advisable at this stage to discuss the asymmetrical forms of the symphysis, a subject touched upon by Aeby, for they can better be presented after we have considered the female, negroid and Primate material.

NATURE OF THE POST-ADOLESCENT BONE CHANGE IN THE PUBIS

When John Hunter commenced his investigation upon the jaws and teeth, his attention was arrested by the fact that not only does the mandible grow in size but it is constantly remodelled to provide for the development and compensate for the loss of teeth (9). Extending his observations to the femur Hunter was confirmed in his conviction that bony change consists of two phenomena—*increase* (or

decrease) of substance and remodelling (10). In spite of the years which have elapsed since Hunter made this discovery Anatomists still fail to grasp the full significance of these axioms of bone change. During the past ten years Keith has emphasized anew the cardinal features of bone change (*e.g.* 11) and many of his theses find ample confirmation in studies under way in this laboratory.

With reference to the nature of the bony change at the pubic symphysial face I have been unable to find any direct statements except those by Cleland (1). Early in the paper Cleland speaks thus of unequal growth [*i.e.* increase of substance] at the symphysial face: "Doubtless, also, the body of the pubic bone continues to grow more rapidly towards the perineal border of the symphysis than at the abdominal border." Cleland formed the impression that the lower extremity of the symphysial face becomes defined before the upper, and in this we have seen that he was justified. But further on in the article the subject of age changes in the relationship of the conjugate and transverse diameters of the true pelvis is discussed. In reference to elongation of the pelvic brim, Cleland states that, "further, the sutures of the acetabulum become obliterated about puberty; and after that occurs the iliac part of the brim is incapable of elongation, while growth at the symphysis continues till adult life." I am not clear as to just when Cleland would consider adult age to be attained for he proceeds "the statement that the iliac and ischial epiphyses may not be completely united to the main bone till the twenty-fifth year is probably correct. But the os innominatum is complete at both these places considerably earlier than at the symphysis." It is evident from these and other parts of the paper that Cleland believed growth to occur in the sense of actual appreciable addition of bony substance at the symphysial face, sufficient indeed to cause alterations in the shape of the pelvic inlet after puberty. Aeby makes the statement that at fifty years the ossification process, if it has not reached its end has at least sunk to a minimum (5, p. 23). It seemed to me, in view of these statements, that we must ascertain precisely upon our material the nature of the bony change, for this can only be done on specimens the age of which is known. For this purpose I measured the ilio-pectineal line (*linea arcuata*) on both sides of each pelvis of all our male white specimens of known age from eighteen years to forty inclusive, comprising phases 1 to 8, subdivided the arc into its iliac and pubic components and expressed the pubic component as a percentage of the whole. In this investigation 113 pelvises were used,

all being of known age. It will be noted that I measured the arc and not the chord. Cleland used the chord which is very misleading, as indeed he himself tacitly admits when he speaks of the considerable variety in the precise curve of the iliac component. The specimens of which only one os innominatum was available are included as they do not vitiate the results; they are marked by an asterisk. My technique is the following: The instrument used is a flexible steel measuring tape graduated in millimeters. The ilio-pectineal line is followed to the symphysial face and this termination is indicated by a pencil mark on the bone. The line is then followed backward to the auricular surface and the most forwardly projecting point of this articular area is also indicated by a pencil mark; this mark is not necessarily upon the ilio-pectineal line which often veers upward tangentially to the auricular surface. The ridge extending over the ilio-pectineal line from the prominence of the same name and marking the union of pubis and ilium is then traced in pencil. This ridge is often very slight and can usually be appreciated more exactly by touch than by sight. It is present upon all bones either as a ridge, which sometimes may be quite faint, or as a slight change in texture or color of the bone. The lengths of right and left ilio-pectineal lines and their pubic components are then averaged and expressed as the *pubic-arcuate index*, thus:

$$\frac{\text{Pubic component average} \times 100}{\text{Ilio-pectineal arc average}}$$

According to Cleland the iliac and pubic chords are equal up to puberty, but after this the latter chord increases so that "in the European adult the pubic exceeds the iliac length from a quarter to three quarters of an inch." If the chord increases it follows that the arc must increase more.

Our results (Chart 2) in no way confirm Cleland's statement, unless his reference to adult age means twenty-one years and not the completion of the symphysial face. For practical purposes the bony change at the symphysial face after eighteen years of age represents a metamorphosis and not a growth.

In the polygon of phases the specimens are arranged in sequence of the pubic-arcuate index and not by sequence in the phase itself. Absolute precision in the order of specimens in development is a difficult task and in the end unprofitable. In all phases except the first and second the range of index is practically the same, more than

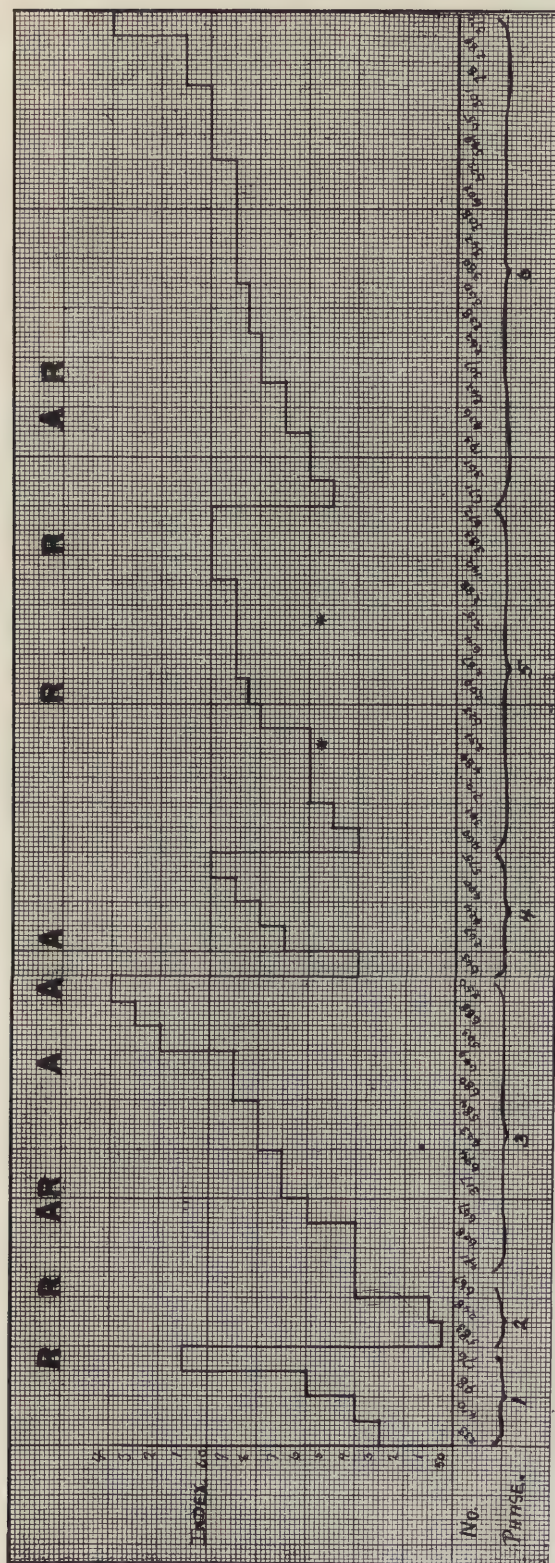


CHART 2. Polygon of pubic-arcuate index. Male white pelvises of known age.

The polygon is arranged by phases and includes only those specimens the ages of which range from 18 to 40 years. Within each phase the specimens are arranged according to index so that the lowest and highest ranges are readily seen. It will be observed that the ranges are practically the same through the entire series which means that there is no growth (*i.e.*, increase of substance) in the pubic component after the age of 18 years.

A. Specimen showing some acceleration of metamorphosis.
R. Specimen showing some retardation of metamorphosis.

(Cont'd p. 322.)

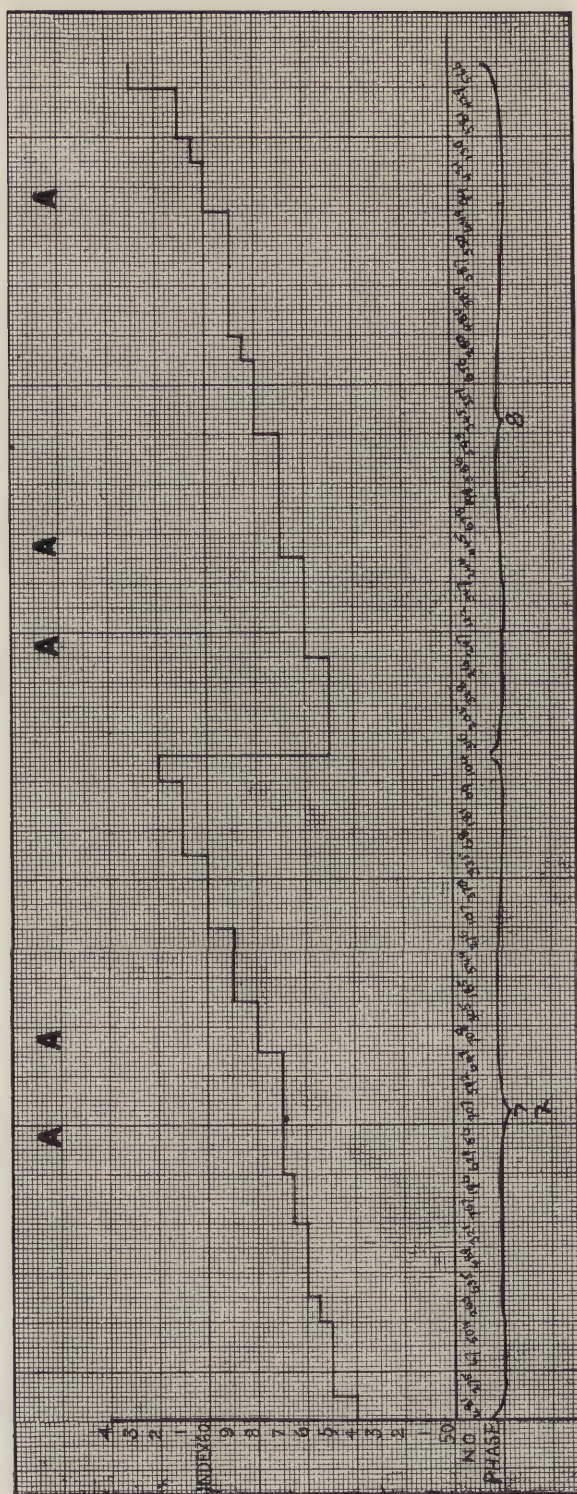


CHART 2a. Polygon of pubic-arcuate index. Male white pelvis of known age.
A. Specimen showing some acceleration of metamorphosis.

three fourths of the pelves falling into the group with index of 55 to 60. If the limits 54 and 61 are taken as the normal extremities, then more than 90 per cent fall within the range.

It is true that the very young pelves of phases 1 and 2 have very low pubic-arcuate indices, and one must concede that probably some actual growth does occur between puberty and about twenty-one years. But after this age the polygon indicates simply individual variation, all phases having practically the same range.

It is important to note that those cases which I have regarded as anomalous, in that they are either advanced or retarded in phase for their age, do not lie at the extremes of the range. Neither hurrying up or slowing down of the bone change at the symphyseal face has any appreciable effect upon the pubic-arcuate index except in No. 176 (Fig. 60), which is pathological in its retardation. Even this specimen however shows remarkably little addition of tissue in the symphyseal face, considering the fact that at age thirty-nine its pelvis is still at about the seventeen-year stage.

To check this observation a polygon of the pubic-arcuate index was arranged in sequence of age. This polygon, including precisely the same pelves as Chart 2, showed precisely the same results. Apart from the slight increase of substance before the age of twenty-two years there is no evidence of actual growth. The maximum thickness of bone added to the symphyseal face after the eighteenth year is probably fairly represented by the depth of the symphyseal 'cap' in Fig. 63 (see pl. V). Owing to the ventral beveling, more bone is added by the ventral rampart to this margin and to the lower (perineal) extremity than to the other parts of the symphyseal face. In this photograph of No. 267, age twenty-five, the distinction between the porous bone of the pubic body and the more compact ventral rampart can clearly be seen. The specimen was chosen for photograph because in view of its rapid development the distinction between these two masses of bone is strikingly evident.

There are two other dimensions besides thickness which must receive consideration, namely height and breadth of the symphyseal face.

Aeby observed (5, p. 22) that at puberty the symphysis has pretty well reached its normal size, but he was dealing with fresh unmacerated pelves. We have seen from results previously set down in this paper that upon macerated material the symphyseal height cannot be definitely stated until about the age of twenty-seven to thirty years, and

even up to thirty-five there may still be some doubt because until the extremities of the surface are defined its vertical diameter can only be estimated. In measuring the vertical height of the symphysis the following limiting points were used: above, the margin of the symphyseal plateau which forms an abrupt edge with the upper surface of the pubis; below, the edge of the symphysis from which there falls away the ridge to which the subpubic ligament is attached. In cases where there is a definite *rim* to outline the symphysis I have taken the upper and lower extreme margins of the rim as my standard limits.

So far as absolute height is concerned our records tend to confirm Aeby's view that the pubic symphysis does not increase in height after adult age is reached. The individual variation in symphyseal height is considerable, however, and to check the observations made on absolute height I resolved to form an index of the symphyseal height based upon a stable unit. In these pelvic studies I had long before been compelled for two reasons to abandon the total pelvic height instituted by Turner and Garson as a basis. My first objection is that the total height is made up of two components, an iliac and an ischial; that these components are influenced by entirely different factors; and that iliac and ischial elements being set at varying angles in different Primates give a total height which is not comparable throughout the Primate series including Man. My second objection is that the total pelvic height cannot be measured, because the precise position of any landmarks differs from pelvis to pelvis so that the loose term "greatest height" gives merely the roughest comparison. The pubic symphysis however is part of the true pelvis and as such should be compared with the height of the true pelvis alone. Limits for the measurement of true pelvic height can be precisely defined and the measurement applies equally to Man and to other Primates. Above, the limiting point is the line of union of pubic and iliac bones where this cuts across the ilio-pectineal line (*linea arcuata*). The limit below is that point, upon a more or less clearly defined line separating the area of muscular attachment upon the tuber ischii from the area covered by fibrous tissue and bursa, which is furthest removed from the upper limiting point. This is found approximately in the center of the transverse diameter of the tuber. The symphysio-pelvic index is obtained thus:

$$\frac{\text{Average height of right and left symphysis} \times 100}{\text{Average of right and left true pelvic heights}}$$

The upper limit can always be felt by the finger within one millimeter to iliac or pubic side, even though it is scarcely visible. Sometimes there is a slight ridge or even a bridge of bone forming a mound above the regular line of the *linea arcuata*. In case such a mound is present the measurement is taken below the mound in the direct line of the *linea arcuata*.

The lower point is not always quite clearly defined. This is especially true of young subjects, in whom however the symphysis is also not measurable. The point has no reference to the most outstanding part of the tuber which in some cases is most prominent below the limiting point, sometimes above it.

The symphysio-pelvic index, like the absolute height of the symphysis, gives no evidence so far of increase in symphyseal height after adult age is reached.

In the last place the maximum antero-posterior diameter of the symphyseal face has been investigated. The measurement of this is quite simple and the only tangible result is the one which would be expected from the description of phase 9, namely that during this period there is slight increase in symphyseal breadth. The increase however is entirely due to the lipping which is characteristic of the phase.

The great mass of figures connected with these observations on symphyseal height and breadth is not presented in this paper. In later studies upon the pelvis it may serve some useful purpose but at present it would only convey in cumbersome and obscure form what can be stated briefly and much more clearly in a few works. What I do feel is important is to record the method adopted and the reasons for its adoption.

It has been noted from the foregoing pages that from the eighteenth year onward the changes undergone by the pubis are largely if not entirely a metamorphosis and not an actual growth, at least in the neighborhood of the symphyseal face. Cleland's observation upon the increased distance in older pelves between the "limiting lines of the femoral muscles of right and left sides" was based on a misconception of the pubis. It is the formation of the ventral rampart which causes the muscular attachment to recede from the edge of the pubis in the macerated bone, but this is no evidence that an increase in distance is to be met with in fresh or living subjects.

As regards Aeby's work, we recall that it was done upon fresh non-macerated material and by horizontal sections through the symphysis.

The observations made by Aeby are thoroughly confirmed by the work now presented, the only difference being that whereas Aeby's descriptions are all of sections through the symphyseal face, ours refer to the features of the surface fully seen. How close are the resultant observations obtained by the two methods of attack can be clearly seen by comparison of the synopsis of the various phases as given above with the extracts of Aeby's work quoted earlier in the paper. Only in minor details do marked discrepancies occur.

SUMMARY AND CONCLUSIONS

A. SUMMARY

1. Distinct changes occur in the adult skeleton unrelated to childhood or senility. These are sufficiently closely related to age as to be valuable as time-markers.
2. Among the age changes are certain characteristic features of bone adjacent to certain joints, the bone surface resembling in part a diaphyso-epiphyseal plane.
3. The pubic bone adjacent to the symphysis presents features of this kind.
4. The present paper deals with male white pelvises of known age. It is to be followed by observations on female, negro-hybrid, and Primate pelvises generally.

B. CONCLUSIONS RELATIVE TO THE MALE WHITE OS PUBIS

5. The ossification of the pubic tubercle is completed by the creeping of new bone over the rough diaphyseal face of the tubercle and not necessarily by the union of a characteristically ossified epiphysis.
6. Ossified epiphyses for the symphyseal face are rudimentary, erratic in their occurrence and very irregular in form. When they occur they rapidly fuse with the symphyseal surface, usually in its upper area, taking part in the formation of the upper extremity and losing their identity very quickly.
7. The symphyseal face undergoes a distinct metamorphosis after puberty. Of this the various phases are tabulated on p. 328. They have a definite but not an invariable age relationship.
8. In occasional cases this metamorphosis is not carried to completion as regards ventral margin and upper extremity.
9. Partial acceleration or retardation is exhibited in the metamorphosis of a few specimens (*e.g.*, No. 142). Had such individuals

lived a few more years the modification might have become more distinct.

10. Anomalies of the symphysis may affect the age relationship of its metamorphosis.

11. General diseases and habits of life also affect more or less profoundly the age relationship of the pubic bone change.

12. In most cases there is a practical harmony in the age relationships of various parts of the skeleton, but occasionally the stage of bone change in the os pubis finds itself at variance with the indications of other bones.

13. Investigation by various methods shows that there is little actual increase of bony substance at the symphyseal end of the os pubis after the eighteenth year, and none at all after the twenty-first. In the main and practically entirely the symphyseal change is one of metamorphosis.

APPENDIX

I. CLASSIFICATION OF PUBIC BONES: MALE WHITE PELVES FOR
KNOWN AGE

Age	Phase	Subjects	Age	Phase	Subjects
18	1	98, 410 (wet specimen)	40	7	67, 69, 185, 196, 276, 335, 459
19	1	391		7-8	244
20	2	233		8	199, 316, 347, 429 (upon phase 6), 431, 449, 566, 582 (upon phase 6), 587 (upon phase 6), 656
21	2	583		8-9	351, 586
22	3	248		9	26 (upon phase 6), 593 (upon phase 6), 740 (upon phase 7)
		256 (admixture of phase 6), 503, 649 (admixture of phase 5)		41	8
		72 (wet specimen)		8-9	295, 375 (upon phase 6)
23	3	471, 480, 694		42	8
24	3	423, 628, 667 (admixture of phase 5), 688.		8-9	650
25	3	584		8	227, 314, 640 (upon phase 6)
	4	267 (admixture of phase 6), 575.		8-9	494
26	4	424, 490, 643		9	255, 365, 654 (upon phase 7)
27	3	317, 687		6-7	661
	5	287, 341, 614, 672	43	8-9	189
28	5	215, 251, 469		9	194, 605 (upon phase 7), 608
	8	94 (very anomalous)	44	10	348 (upon phase 8)
29	5	288, 436 (admixture of phase 6), 712		8	374, 395, 518 (upon phase 6)
30	5	142, 484, 623		8-9	73, 80, 156, 313, 320, 336, 444
	6	65, 238, 360		9	268, 274 (upon phase 7), 282, 369, 460 (upon phase 7), 689, 787
	8	247		10	285, 467
32	6	78, 549		9	155, 186 (upon phase 6), 364
	6-7	635		8	214
	7	107 (slightly pathological), 707, 708		8-9	39, 41, 318
33	6	193, 289, 671		9	36, 669 (upon phase 6), 701, 711
34	6	301, 342		48	8
	6-7	629		9	210 (commencing; upon phase 6)
	7	489		9	213, 322, 390, 559 (upon phase 7)
35	5	383		9-10	296, 354
	6	242, 262, 308, 361, 371, 602, 622		10	745
	6-7	104, 305, 592		9	208
	7	56, 68, 370, 544		10	344 (pathological), 507
	7-8	205, 280		50	9
36	5	209		9-10	218, 261, 265 (upon phase 7), 266, 398, 432, 535, 648, 732
	5-6	307		10	183 (?pathological), 200, 382, 492
	7	767		10	50 (upon phase 8), 195
	8-9	445		8	468
37	6-7	181		9-10	264, 377
	7	263, 504		8	18 (pathological?)
38	6	380		8-9	292
	7	275, 321, 481, 647			
	7-8	345, 480			
	8	328, 581, 678			
	8-9	389			
39	1	176 (Hypophysial tumor).			
	8	112 (superposed on phase 6), 130			
	8-9	550			

Age	Phase	Subjects	Age	Phase	Subjects
52	9	23 (upon phase 7), 202, 562	65	10	464 (upon phase 6), 579,
	9-10	372			686 (upon phase 8), 691
	10	496	66	9-10	207, 358
53	9	28, 197, 325, 609		10	309
	10	547, 641	67	9-10	329
54	9	418, 463 (upon phase 6),		10	76 (strongly resembles
		789			phase 6), 483 (upon
	9-10	48, 322, 610, 726			phase 6)
55	9	597	68	9-10	35, 353
	9-10	270, 303, 499, 537, 615,		10	186, 286, 573
		621, 746	69	9	277
	10	300 (upon phase 6), 477		10	271, 571
56	9	258	70	9	284
	9-10	452		9-10	304
	10	393, 554		10	187 (upon phase 6), 191,
57	9	797			216 (upon phase 6)
	9-10	212, 788	71	9	37
58	9	487		9-10	683
	9-10	479	72	10	179
	10	253	73	9-10	739
60	9	556, 636, 651		10	272
	9-10	21, 82, 217, 220, 250, 546,	74	9	224, 323
		551, 663	75	9	66
	10	396, 660, 780		9-10	236
61	9	219	77	9	283
	9-10	239		9-10	92
	10	294		10	114
62	9-10	231	79	9-10	77
	10	567 (pathological)	81	10	397
63	9	319, 349	82	10	381 (pathological)
	9-10	206	83	10	616
	10	312, 359, 557	86	10	235
64	9-10	71, 75, 363, 665	87	10	51
65	9	299, 426	88	10	115

In the foregoing statement several comments are made. In case the specimen is distinctly pathological the fact is recorded. A mingling of two phases in any one specimen is duly noted. Where a later phase is mingled with the earlier typical one the mingling is stated as an admixture. These notes are not found on specimens of more than twenty-nine years, but where they occur they indicate a tendency to unusually rapid metamorphosis. In specimens of age thirty-nine and over markedly advanced metamorphosis is not so obvious nor so easily identified. Among these retardation is the striking feature. The characteristic phase is recorded as supervening upon the earlier phase during which metamorphosis of the retarded specimen became inhibited or greatly slowed down. Naturally frank cases of acceleration or retardation are recorded by phase without comment. One immediately wonders if acceleration and retardation are characteristic

of early and late adult life respectively. The list of specimens answers this in the negative. Then one asks oneself if retarded specimens have their metamorphosis inhibited or simply slowed down. No satisfactory answer can be returned to this question upon the basis of the number of examples here recorded. The subject will be taken up after presentation of female and negro-hybrid pelvises in a later communication.

II. DATA FOR PUBIC-ARCuate INDEX

The figures for the estimate of this index will be presented along with those for the female and negro-hybrid pelvises in later communications.

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EXPLANATION OF PLATES

PLATE I.

The symphyseal face of phases 1, 2 and 3 comprising ages 18 to 24 years.

PHASE 1. FIGS. 4, 5, 6.

FIG. 4. No. 98, age 18. Symphyseal face rugged; traversed by horizontal ridges and furrows. Ridges are more massive above and transverse entire breadth of face. Below they are smaller, tend to be confluent and do not pass across the entire surface. No bony nodules on upper part of face which extends to pubic tubercle. No definite margins: no delimitation of extremities. Appearance of delimitation below on right side is due to photographic foreshortening.

FIG. 5. No. 410, age 18. Symphyseal face no longer extends as far as pubic tubercle.

FIG. 6. No. 233, age 19. Definitive dorsal margin commencing on left side only as ridge which connects up the hinder extremities of the horizontal ridges.

PHASE 2. FIGS. 7, 8.

FIG. 7. No. 583, age 20. Dorsal delimiting margin is now present on both sides.

FIG. 8. No. 248, age 21. Adjacent to growing dorsal margin the horizontal furrows are filling with new, finely textured bone which is wrecking the hinder extremities of the ridges. Bony nodule fusing with upper left face. Illusion of delimited lower extremity is entirely due to photographic foreshortening.

PHASE 3. FIGS. 9-16 incl.

FIG. 9. No. 503, age 22.

FIG. 10. No. 471, age 23.

FIG. 11. No. 680, age 23.

FIG. 12. No. 694, age 23.

FIG. 13. No. 628, age 24.

In all these figures the dorsal margin remains about as it is in phase 2 but the surface pattern of ridges and furrows is being wrecked first by the growth of the dorsal plateau adjacent to the dorsal margin and secondly by the beveling of the ventral strip (compare Fig. 2). The bony nodule occurs on all. No delimitation of extremities.

FIG. 14. No. 423, age 24. An example of the shallow-furrowed type of symphyseal face. Bony nodules present.

FIG. 15. No. 688, age 24. Dorsal plateau extends forwards over one third breadth of face. No bony nodules.

FIG. 16. No. 584, age 25. Contrast the distinctions of ridge and furrow system of this specimen with that of No. 688 although same stage is exhibited in both. Bony nodules present.

PLATE II.

The symphyseal face of phases 4 and 5 comprising ages 25-30 years.

PHASE 4. FIGS. 17-20 incl.

FIG. 17. No. 575, age 25.

FIG. 18. No. 643, age 26.

FIG. 19. No. 424, age 26.

FIG. 20. No. 490, age 26.

All these specimens show continuance of wrecking of ridge and furrow system with obscuring of identity of bony nodules (except in No. 424 where they do not occur). Note the greatly increased ventral erosion and the commencing formation of the lower extremity.

PHASE 5. FIGS. 21-30 incl.

FIG. 21. No. 614, age 27.

FIG. 22. No. 341, age 27.

FIG. 23. No. 672, age 27.

FIG. 24. No. 287, age 27.

FIG. 25. No. 251, age 28.

FIG. 26. No. 215, age 28 (left only).

FIG. 27. No. 712, age 29.

FIG. 28. No. 288, age 29.

FIG. 29. No. 142, age 30.

FIG. 30. No. 623, age 30.

The symphysial face has undergone little change from phase 4, but the lower extremity becomes better marked and sporadic attempts occur at formation of ventral rampart. In some the bony nodules have developed and are losing their identity. No. 142 retains the ridge and furrow system to a marked extent. The upper extremity is beginning to form on all with or without the aid of a bony nodule.

PLATE III

The symphysial face of phase 6 comprising ages 30-35.

PHASE 6. FIGS. 31-44 incl.

FIG. 31. No. 238, age 30.

FIG. 32. No. 65, age 30.

FIG. 33. No. 360, age 30.

FIG. 34. No. 78, age 32.

FIG. 35. No. 635, age 32.

FIG. 36. No. 671, age 33.

FIG. 37. No. 193, age 33.

FIG. 38. No. 289, age 33.

FIG. 39. No. 342, age 34.

FIG. 40. No. 301, age 34.

FIG. 41. No. 305, age 35.

FIG. 42. No. 104, age 35.

FIG. 43. No. 242, age 35.

FIG. 44. No. 262, age 35.

The outstanding features of this phase are the increasing definition of the extremities and the formation of the ventral margin. Often but not always the latter is formed by the building up of an actual rampart by extensions from upper and lower extremities, including also, it may be, occasional bony nodules between. In some cases the ventral margin seems to form in the same manner as the dorsal margin (see No. 78). The symphysial face undergoes little change in this phase.

PLATE IV

The symphyseal face in phases 7, 8, 9, 10 comprising ages 35 years and upwards.

PHASE 7. FIGS. 45-51 incl.

FIG. 45. No. 647, age 38.

FIG. 46. No. 647, medial margin tuber ischii.

FIG. 47. No. 181, age 37.

FIG. 48. No. 321, age 38.

FIG. 49. No. 481, age 38.

FIG. 50. No. 112, age 39.

FIG. 51. No. 196, age 40.

These bones all show changes in the symphyseal face (and ventral surface) consequent upon diminishing bone activity.

Fig. 46 shows the lipping which occurs during this phase at the attachment of the sacro-tuberous ligament.

PHASE 8. FIG. 52.

FIG. 52. No. 314, age 42.

Note relatively smooth and generally inactive symphyseal face with complete oval outline, clearly defined extremities, no "rim" or marked lipping of margins.

PHASE 9. FIGS. 53, 54.

FIG. 53. No. 202, age 52. Shows the development of a distinct narrow border or "rim" to the margin.

FIG. 54. No. 325, age 53. Shows uniform dorsal lipping and irregular ventral lipping.

Either or both of these features are present in phase 9.

PHASE 10. FIGS. 55-58.

FIG. 55. No. 382, age 50. Shows erosion of upper third of ventral margin.

FIG. 56. No. 547, age 53. Shows erosion primarily of symphyseal face and secondarily of ventral margin.

FIG. 57. No. 253, age 58. Marked erosion of surface and break-down of ventral margin.

FIG. 58. No. 359, age 63. Complete senile transformation of symphyseal face.

PLATE V

Examples of anomalies in age-relationship of change in os pubis.

FIG. 59. No. 94 age 28. Acceleration of development related to anomaly in form.

FIG. 60. No. 176, age 39. Very marked retardation of pubic development associated with osteoma in sella turcica.

FIG. 61. No. 649, age 22.

FIG. 62. No. 267, age 25.

FIG. 63. No. 267, ventral surface of ossa pubis.

FIG. 64. No. 667, age 24.

FIG. 65. No. 708, age 32.

FIG. 66. No. 68, age 35.

All these specimens show acceleration of pubic metamorphosis. For descriptions see text.

Fig 63 shows the ventral rampart of denser bone standing upon the more porous ventral beveled strip.

FIG. 67. No. 317, age 27.

FIG. 68. No. 307, age 35.

FIG. 69. No. 185, age 40.

FIG. 70. No. 210, age 48.

FIG. 71. No. 26, age 40.

FIG. 72. No. 464, age 65.

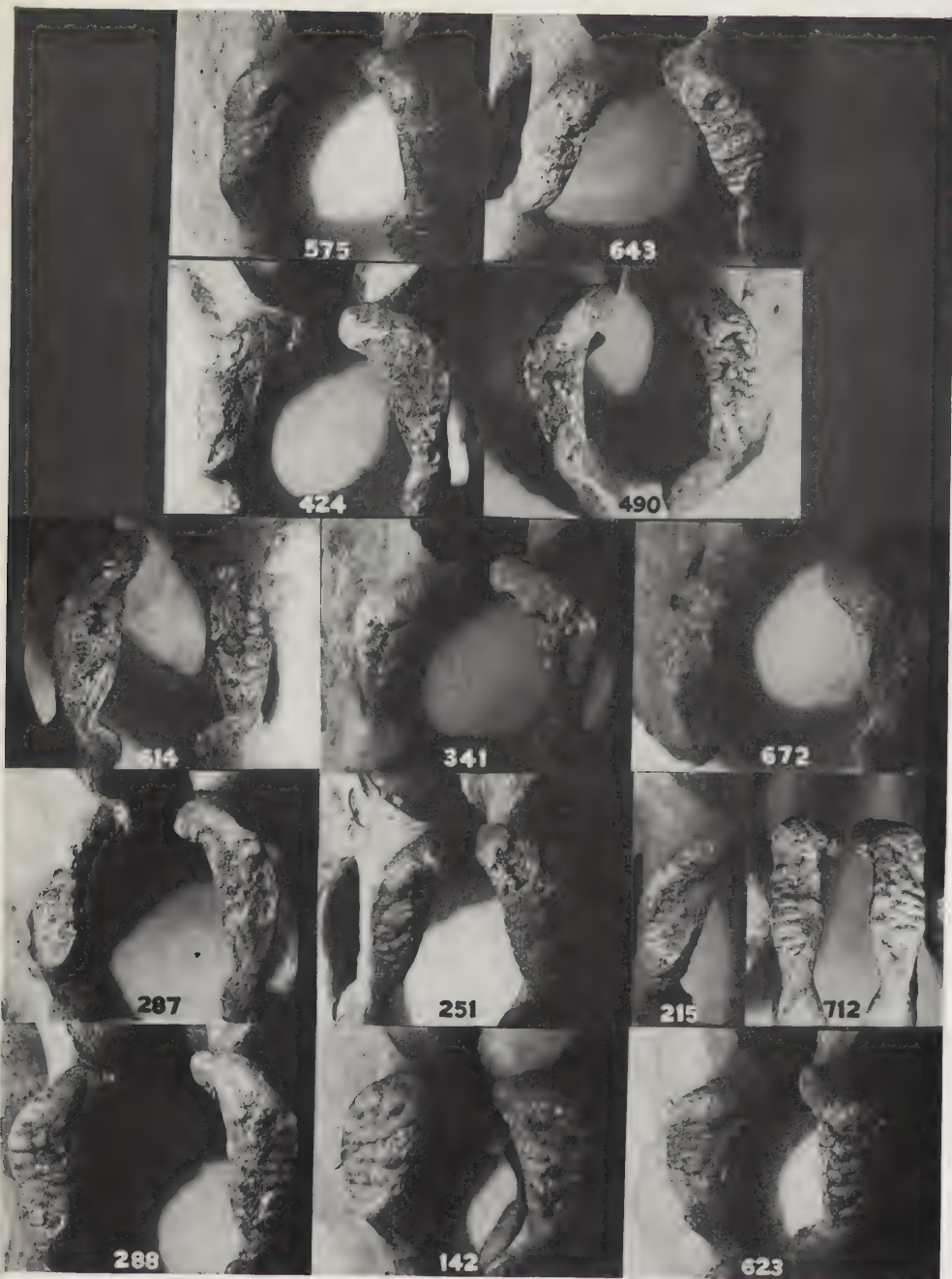
All these figures show retardation of metamorphosis. For complete description see text.

PLATE I.



FIGURES: Uppermost row — Figs. 4, 5, 6; second row — Figs. 7, 8; third row — Figs. 9, 10, 11; fourth row — Figs. 12, 13, 14; lowest row — Figs. 15, 16.

PLATE II



FIGURES: Uppermost row — FIGS. 17, 18; second row — FIGS. 19, 20; third row — FIGS. 21, 22, 23; fourth row — FIGS. 24, 25, 26, 27; lowest row — FIGS. 28, 29, 30.

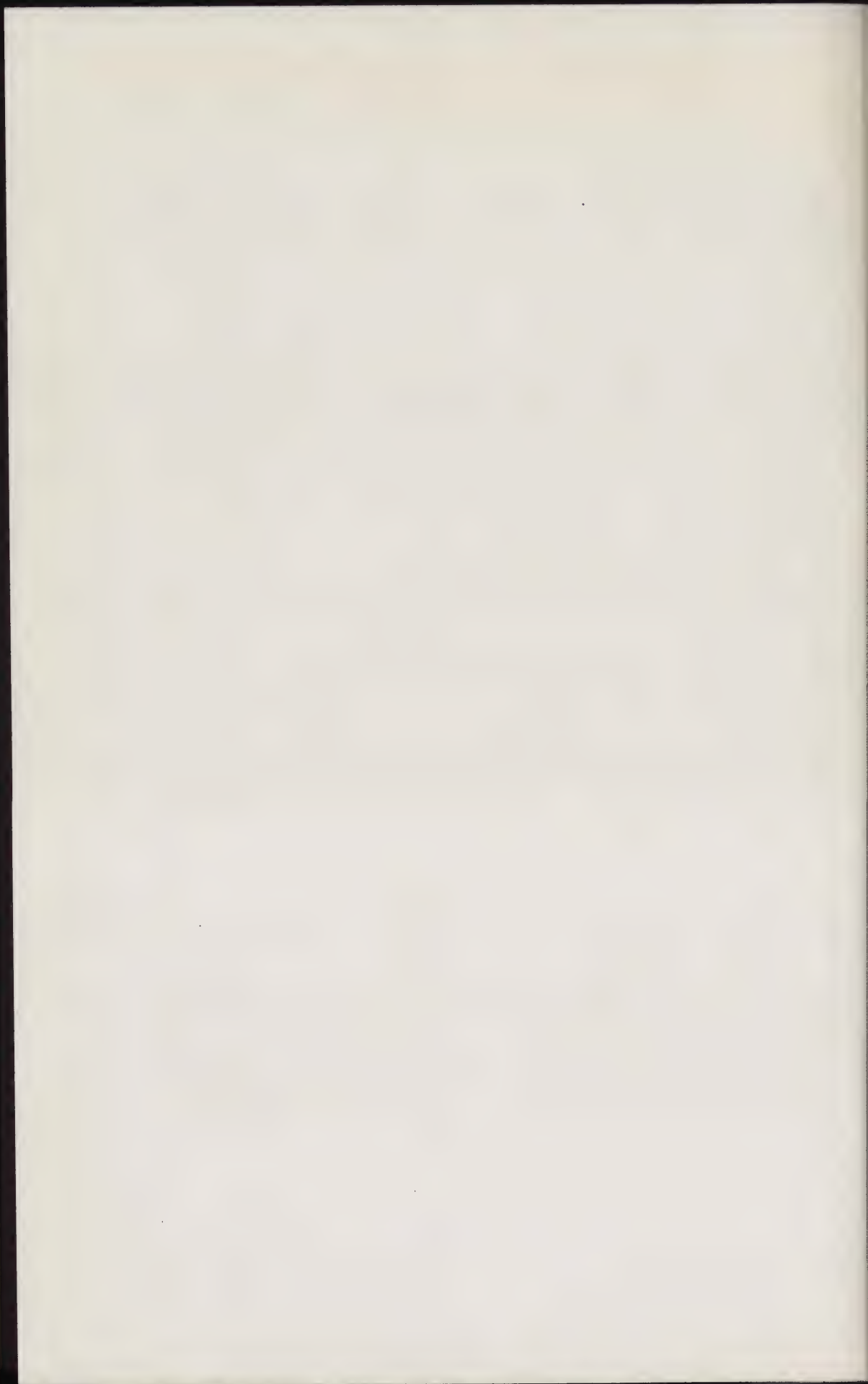


PLATE III



FIGURES: Uppermost row — FIGS. 31, 32, 33; second row — FIGS. 34, 35; third row — FIGS. 36, 37, 38; fourth row — FIGS. 39, 40, 41; lowest row — FIGS. 42, 43, 44.

PLATE IV



FIGURES : Uppermost row — FIGS. 45, 46; second row — FIGS. 47, 48, 49; third row — FIGS. 50, 51, 52; fourth row — FIGS. 53, 54, 55; lowest row — FIGS. 56, 57, 58.

PLATE V



FIGURES: Uppermost row — FIGS. 59, 60; second row — FIGS. 61, 62, 63; third row — FIGS. 64, 65, 66; fourth row — FIGS. 67, 68, 69; lowest row — FIGS. 70, 71, 72.

STUDY OF ABNORMALITIES AND PATHOLOGY OF ANCIENT EGYPTIAN TEETH

SIR ARMAND RUFFER*

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I. INTRODUCTION

Mummery's¹ classical paper dating from over 45 years ago, to which I shall refer repeatedly, was the only contribution of any permanent value regarding the incidence of dental disease in Ancient Egyptians, until the publication, by two members of the Archæological Survey

* My late husband intended to publish almost simultaneously with this paper on the Ancient Egyptian Teeth, another on Arthritis and Spondylitis, considering dental disease an important ætiological factor in the causation of arthritis.

Owing to his untimely death, he left the latter work incomplete, and I have been unable to supply many missing links between the two papers, as I cannot prove to my satisfaction that certain diseased teeth, mandibles, etc., belong to the same skeletons which show marked arthritic lesions of various joints. However, with the kind assistance of Capt. Willmore, R.A.M.C. I have finished the paper on arthritis to the best of my ability, and it will appear shortly in the *Journal of Pathology*.

A third paper was begun in connection with the present one, for on remarking the effect of the food of the people in producing attrition, caries, etc. Sir Armand made a study of the food of the ancient Egyptians.

These with three other papers which I shall endeavor to finish for him, and fourteen which he had already published, were destined to form parts of a book he intended to call "STUDIES IN PALÆOPATHOLOGY."

ALICE RUFFER.

The "Marc Armand Ruffer" referred to in some of the footnotes is Sir Armand Ruffer. Ed.

¹ Mummery (J. R.)—*Trans. Odont. Soc.*, Gr. Brit., 1870, ii.

(A. S. N.) of Nubia, G. Elliot Smith and F. Wood Jones, of the report on the human remains found in Nubia.¹ Elliot Smith was responsible for the anthropological work, the field notes and the whole of the pathological section being Dr. Wood Jones' contribution. The independence of judgment of both observers is demonstrated by the fact that they do not always entirely agree regarding the conclusions to be drawn from their observations. Their memoir, published in 1910, is valuable, first on account of the large number of skeletons examined, and second because all the material is dated—a most important point, as Egyptian or Nubian skeletons may belong to any period from over 4,000 B.C. to the present time, a stretch of over 6,000 years. The excavations in Nubia brought to light skeletons dating from some time before dynastic times, that is before 3,400 B.C., down to the Coptic and Christian times. The field notes are not the least valuable part of the work and have been carefully analyzed by me, and indeed, except for some observations made² at Merowe and Faras, practically the whole of my remarks regarding dental disease in Nubia will be based on this memoir.

Interesting facts concerning dental disease in Ancient Egypt are to be found in Elliot Smith's description of the Royal Mummies in the Museum of Cairo.³ A most valuable collection was the series of skulls discovered by the Hearst expeditions of the University of California. These are repeatedly alluded to by Elliot Smith in several of his anthropological papers, but I am not aware that a full account of the pathological lesions of these skulls has ever been published; they are now in the United States, partly at the Museum of the University of California and partly at Harvard. The Museum of the Medical School in Cairo contained for a time a large number of these and they, with additional ancient Egyptian crania collected by Elliot Smith, Derry and others, were repeatedly examined by me. Skulls from the Nagaed-Deir, dating from the VIth to XIIth dynasties, Coptic skulls from the same locality, and skulls from the pyramids of Gizeh belonging to the IVth and Vth dynasties, were also studied. All this material proved most useful for forming an opinion as to the nature of the dental and other⁴ lesions, but owing to the large number

¹ The *Archæological Survey of Nubia*, 1907-1908, ii; Report on the Human Remains, by G. Elliot Smith and F. Wood Jones, Cairo, 1910. This work will in future be referred to as A. S. N.

² Ruffer (Marc Armand)—Note on the diseases of the Sudan and Nubia in ancient times. *Mitt. z. Gesch. d. Med. u. Naturw.*, 1914, xiii, 453.

³ Elliot Smith (G.)—The Royal Mummies, Cairo, 1912.

⁴ Ruffer (Marc Armand) & Rietti (Arnoldo)—On Osseous Lesions in Ancient

of teeth lost in the graves, it was practically useless for a statistical study regarding the incidence of any particular form of dental disease.

For part of the material on which this paper is based, my best thanks are due to the late Sir Gaston Maspero, to Professor W. M. Flinders Petrie and his collaborators, to Professor G. Elliot Smith, and to Professor A. Breccia of the Museum of Alexandria.

At Chatby, near Alexandria, about two minutes' walk from the sea, lie the tombs of the Macedonian soldiers of Alexander the Great and Ptolemy I. In view of the constant growth of the town, which will soon extend over the whole of this region, the Municipal Commission ordered an archaeological survey of this site. The work was entrusted to Professor E. Breccia,¹ the Curator of the Alexandria Museum, who gave us permission to examine most of the bones found in the necropolis, and to be present during some of the excavations. Owing to a lawsuit, the work has been suspended for a time, and this delay is specially unfortunate because the names on the tombs to be yet opened indicate that the crypts contain the skeletons of the prostitutes who accompanied the Greek army. Here, if anywhere, evidences of syphilis should be found, provided venereal disease existed at that period.

The bodies here had been placed in rock-hewn graves. The first grave was an "ossarium" measuring about 2 cubic metres, filled with sand and bones, and closed with a stone slab which had been sealed with mortar. The bones, after the bodies had undergone decomposition elsewhere had been thrown into the ossarium, and little care had evidently been taken in their gathering, as among the human bones the femur of a horse was found. The other graves were horizontal shafts, three and one half feet high, six feet deep and about three and one half feet wide, cut in the solid rock and closed in the same manner as the ossarium. Rarely, such a tomb contained but one body, lying on a layer of sand about 6 inches deep; as a rule, several skeletons, five, six or even more, were present. Funeral urns filled with ashes or half-carbonized bones were discovered also. The Egyptians. *J. Path. & Bact.*, 1912, xxvi, 439. Ruffer (Marc Armand)—Studies in Palæopathology in Egypt. *Ibid.*, xviii, 149.—Pathological Notes on the Royal Mummies of the Cairo Museum. *Mitt. z. Gesch. d. Med. und d. Naturw.*, 1914, xiii, 239.—Note on the Diseases of the Sudan and Nubia in Ancient Times. *Ibid.*, 453.—with Rietti (Arnoldo)—Notes on two Egyptian Mummies. *Bull. Soc. Archéol. d'Alexandrie*, No. 14, 3.

¹ This eminent archæologist will soon publish a full account of his researches, which will throw much light on the habits of the Greek immigrants in Egypt.

Greeks of that period, therefore, were eclectic in their customs, some families burning, others burying their dead.

Unfortunately, the level of the land has sunk several feet since the last body was consigned to the grave. Hence, some tombs were partially filled, others merely infiltrated with sea water, and the bones were often found lying in water, or in thick, wet mud. Such skeletons were in bad condition, and most of the smaller with some of the larger bones could not be found, even when the slush was removed carefully by hand.

Although, as might be expected, the bones were rather better preserved in dry than in wet graves, yet this was by no means the rule. The skeleton of a female, for instance, lying on a bed of dry sand, was so fragile that some bones were broken when their removal was attempted; on the other hand, bones lying in liquid mud were sometimes very hard, whereas others, in the same grave, broke as soon as touched.

Sometimes, the soldiers had been buried with their wives and children; nothing however could be learned from the skeletons of the last named, as hardly a single bone was preserved sufficiently well for examination.

We shall not enter into anthropometric details, as the skeletons have been handed over to an anthropologist for examination. We may say, however, that a superficial examination sufficed to show that various races were represented. Of the thirty-two skulls examined, some had high-bridged noses, others remarkably flat ones. Some were brachycephalic, others markedly dolichocephalic; two skulls were evidently negroid. The variations in stature were great also, some men being tall, others short. These differences are not to be wondered at considering that, from the start, Alexander's army was distinctly a "mixed crew." It is stated for instance, in Smith's "Classical Dictionary," that of the 30,000 foot soldiers who left Greece with Alexander, only 12,000 were Greeks; the others were foreigners, chiefly Thracians. The inscriptions on the tombs were in Greek, but it is highly probable that the soldiers settled in Egypt had intercourse with and often married native women, just as their successors have done in modern times. The present Berberine, for instance, especially when coming from Korosko, often boasts that he is a descendant of a Turkish soldier and a native woman, and the term Turk, as used by him, includes Greek, Herzegovinian, Bosnian, Bulgarian and Servian.

Another part of our material was derived from the catacombs of Komel-Shougafa, which are situated close to Pompey's Pillar at Alexandria, and, according to Professor Breccia the bodies dated from the second century after Christ. The tombs contained hundreds of skeletons, most of which however, owing to the gradual infiltration of water, were in such a bad condition that they could not be examined. It has been supposed that these catacombs contained the skeletons of the Alexandrian youths who were massacred by order of Caracalla. A simple examination of the skeletons showed this supposition to be wrong, as the bones were those of men, women and children. On the whole, the mode of burial was almost identical with that seen at Chatby. The first body had been placed on a layer of sand about 4 inches high, and later on the skeleton had been pushed aside to make room for the second occupant.

I was also fortunate enough in obtaining fragments of about forty Egyptian skulls buried at Ras-el-Tin, and dating from the time of Cleopatra, but again, these were quite useless for statistical purposes; and I have examined five Coptic bodies coming from Upper Egypt and dating from the fifth century A.D., while other Coptic bodies were given me by Prof. Breccia, and came from Antinoë in Upper Egypt. The bodies of the latter had been originally placed in wooden coffins and buried in sand. When handed over to me they were dressed in long linen shirts in which they had been buried, and from the embroideries adorning these garments I concluded that these persons had belonged to a wealthy class of the community.

For the purpose of this paper the chronology used in the Archæological Survey of Nubia¹ has been adopted, the dates being those given by Breasted.²

- | | | |
|--|--------------------------------------|---|
| 1. Predynastic period | { Early. }
Middle. }
{ Late. } | These three periods cannot be accurately dated, but they certainly extended before 3,400 B.C. |
| 2. Early dynastic period = the first three or four dynasties.
(Approximately A group.) 3,400-2,750 B.C. | | |
| 3. Old Empire = Fourth to Sixth dynasties.
(Approximately B group.) 2,750-2,475 B.C. | | |
| 4. Middle Empire = Seventh to Sixteenth dynasties.
(Approximately C group.) 2,475 B.C.-1600 B.C. (?) | | |
| 5. New Empire = Seventeenth to Twentieth dynasties.
(Same as D group.) 1,780 B.C.-1200 B.C. | | |

¹ Reisner (G. A.)—*Archæological Survey of Nubia*, Arch. Rep., I, 6.

² History of Egypt, 597.

6. Late period = Twentieth to Thirtieth dynasties. 1200-332 B.C.
7. Ptolemaic Roman period. 332 B.C.-300 A.D.
8. Coptic period. 300 A.D.

II. DENTAL ANOMALIES

The description includes abnormalities in the number, position and structure of deciduous and permanent teeth, which are of both medical as well as anthropological concern.

Irregularities of teeth have been attributed to modern civilization, and are said to be rare in ancient and even some modern races. None were found, for instance, in the large collection of skulls in the crypt of Hythe Church, England, but these, as a matter of fact were comparatively modern, and of mixed origin, most dating from 450 A.D. The frequently quoted comparisons between ancient and modern Britons, or between ancient and modern Italians are of little value, owing to the extensive crossing of races which has taken place, few modern Englishmen and Italians being descendants of ancient Britons and Romans.

The causes of irregularities of teeth in modern times are said to be: (1) premature removal; (2) persistence of deciduous teeth; (3) supernumerary teeth; (4) mouth-breathing; (5) habit of sucking thumbs, lips, tongue or toes; (6) presence of a frenum of the tongue; and still others. The only factors which can be appreciated by examination of skeletal material are the first three.

Abnormalities of the dentition are certainly not peculiar to modern times either in France or in Egypt. The dentition of the *Homo Moustériensis* was, as well known, somewhat aberrant. The eruption of the right canine had been delayed, and the deciduous canine on the same side, already much worn, was still present. It has been maintained that the pathological process accompanying the retention of the left deciduous canine had left traces on the corresponding articulation, for the condyle did not fit the jaw exactly, and its shape differed from that of its fellow, being thicker in the sagittal direction, and shortened in the transverse direction.

In England, abnormalities in the position of the teeth have been seen in prehistoric remains; at Halling and Caithness, for instance. The third lower molar of a skeleton from the brick-earth deposit at Halling, Kent, lay obliquely at the junction of the ramus and body of the jaw, due to want of room.¹ The left upper canine from a pre-

¹ Keith (A).—Report on the Human and Animal Remains found at Halling, Kent. *J. Anthr. Inst.*, 1914, xliv, 234.

historic skull at Caithness was thrust inwards out of its place.¹ Torsion of a canine tooth from the Bronze age found at Adlerberg,² and also from a Hökergrab³ at Reiherwerder, is on record. The roots of the molar teeth at St. Brelade's, Jersey, were conjoined or fused. Abnormalities in the position and structure of the teeth have been discovered in several ancient skulls of France. The incisors and canines of a mandible at Cro-Magnon were compressed laterally and slightly thrust forward, and the left third lower molar was smaller than the others and had two roots only.⁴ A prehistoric skull found in the Carrière Hélie at Grenoble had an "atrophied" third molar.⁵ A bifid canine was found at Grenelle,⁶ and a cranium of La Magdaleine had a very small third molar with two double roots.⁷ Ancient Danish jaws, according to Nielson, also sometimes had teeth aberrantly placed or with an abnormal structure.

These instances, gleaned from the limited literature at the writer's disposal, suffice to show that dental abnormalities were certainly not uncommon in ancient times. Doubtless, the study of further records, and the systematic examination of ancient skulls would add materially to their number.

ABNORMALITIES OF DENTITION IN ANCIENT EGYPTIANS

The supernumerary teeth of modern peoples are often like normal teeth in shape and character. They are more frequent in the upper than in the lower jaw. They resemble a lateral incisor most often, a premolar less frequently, molar rarely, and a canine very exceptionally. The last point, however, calls for a qualification: small conical supernumeraries are not uncommon, but they are more like the deciduous canines, or like the ancestral conical teeth, which they possibly represent, than like the permanent canines.⁸ They occur most commonly in the upper incisor region. Two supernumerary

¹ Laing (S.)—Prehistoric Remains of Caithness; with Notes on the Human Remains, by Th. Huxley. *J. Anthr. Soc.*, Lond., 1865, III, p. XX et seq.

² Bartels (P.)—Über Schädel und Skelettreste der früheren Bronzezeit aus der Umgebung von Worms am Rhein. *Prähist. Zeitschr.*, 1912, iv, No. ½.

³ Busse—Gräber mit Hökerbestattung und Flachgräber auf den grossen Reiherwerder im Tegeler See. *Prähist. Zeitschr.*, 1910, ii, 60-78.

⁴ Quatrefage et Hamy's *Crania Ethnica*, 49.

⁵ *Ibid.*, 120.

⁶ *Ibid.*, 86.

⁷ Quatrefage et Hamy's *Crania Ethnica*, 55.

⁸ Hrdlička (A.)—Physiological and Medical Observations among the Indians etc., *Bull. 34, Bur. Am. Ethnol.*, Wash., 1908, 124.

teeth are occasionally met with in the premolar region, and a supernumerary tooth not unfrequently erupts near, mostly posterior to, the third molar. Supernumerary first and second molars have never been recorded.

Supernumerary teeth have been reported before in Ancient Egyptian skulls.

A very curious case dates from the XII dynasty.¹ The two left maxillary incisors of a youngish man were joined together and formed a large tusk, which certainly did not add to the bearer's good looks during life, and an accessory incisor tooth had perforated the palate behind this extraordinary structure.

A young Nubian woman² of the New Empire period, with normal teeth, had a supernumerary tooth, situated 3 mm. within the nasal margin, and unconnected with the normal alveolar cavities. It was conical in shape, visible from the front, measured 5 mm. in its antero-posterior diameter, and its visible portion was covered with enamel. In the second case, an adult woman from the same grave and a possible relation of the first, the supernumerary tooth had appeared in the palate to the left of the middle line behind the first incisor, and just externally to the anterior palatine foramen.

Supernumerary incisors were seemingly rare in the ancient Nubians, and the writer has found but one case on record. In this person, the tooth had erupted immediately to the inner side of the left maxillary second incisor.³ Similarly, only one instance of a supernumerary canine has been described, and this was situated just behind the left maxillary canine of no less a personage than Queen Nefer buried at Dahshur.⁴ Supernumerary premolars were found in two Nubian negroes only, who, as they occupied neighboring graves, may also have been relations. Each had a supernumerary tooth near the posterior normal premolar; otherwise the jaws were normal with no signs of crowding. The abnormality most often found in the molar region of Nubians was the presence of one or two supernumerary molars.

As to Egypt proper, a supernumerary central upper incisor, and a small supernumerary intercalated between the second and third right lower molars, were found by the writer in one out of 156 Egyptian predynastic maxillæ and 35 mandibles. The fourth molars will be

¹ Murray (M. A.)—The Tomb of two brothers. *The Manchester Museum Handbooks*, Pl. ii, fig. 4.

² A. S. N., 230.

³ *Ibid.*, 170.

⁴ de Morgan (J.)—Fouilles de Dahshur, 1894, 49.

discussed with the abnormalities of the molar region. In a skull from Faras, dating from about 300 B.C., the teeth had all fallen out after death, but the alveolus of a supernumerary was plainly visible to the outer side of the normal first molar. Neither among the Macedonian soldiers, nor among the Copts, nor among the ancient population of Alexandria, were any supernumerary teeth discovered. Attention has been drawn to certain "accessory dental masses,"¹ which were seen somewhat frequently in Nubia, most of them in the alveolar margin posterior to the normal second molars. These have been considered as rudimentary teeth, or perhaps more correctly as the remains of the roots of deciduous teeth.²

The preceding data, while somewhat fragmentary, and not fit for exact comparisons, indicate that while supernumerary teeth did occur among the Egyptians and Nubians, they were not very frequent.

Deficiency in the number of teeth may be studied next.

In modern people the missing elements are almost restricted to the third molars,³ the upper lateral incisors and the second mandibular premolars. Cases where many, most, or even all the teeth are absent are not unknown: but these are pathological cases, and the condition may be associated with great abundance of hair, malformation and other pathological conditions.

Reduction in the number of teeth not due to disease or interference, was rare in ancient Nubia. In a middle Nubian Christian there were only one upper bicuspid and two upper molar teeth on each side. (Lower jaw?). Another Nubian skull showed a similar condition. An Egyptian predynastic skull from Naga-el-Deir had no left lateral upper incisor, and the corresponding right incisor was very small, besides which the right first molar was distinctly twisted. A skull from the same period had no left upper central incisor, in spite of an exceedingly roomy palate. A similar abnormality has been noticed in an ancient Egyptian animal. A monkey, *Papio anubis*, from Thebes,⁴ had three maxillary incisors instead of four, one being missing on the left side. This deficiency was probably congenital as there was no alveolus, and the median line of the premaxillary was displaced to the left, causing marked asymmetry. Petrie,⁵ in his excavations of Hyksos and Israelite cities, found a female human jaw which had only

¹ A. S. N., 238.

² Dixon (F.)—*Proc. B. A. A. S.*, 1908.

³ Colyer (L. E.)—in Smale & Colyer's *Diseases and Injuries of the Teeth*, 1901.

⁴ Lortet—*La Faune momifiée de l'Égypte*. Sér. ii, 11.

⁵ Hyksos and Israelite cities.

one molar on each side and was peculiarly wide and short (2.4 inches wide and only 1.2 inches from back to front, forming a semicircle).

Absence of the first left mandibular incisor must have been fairly common in Lower Egypt, as four such cases have been observed in ancient Alexandria skulls.

Gaps, or diastemæ, between the teeth sometimes occurred in ancient Nubians. In an adult³ man of the Early Dynastic period, a space of 4 millimeters existed between each upper lateral incisor and the canine; his jaws were large and the teeth excellent; another adult man⁴ of the same period showed a gap of three millimeters in the same position, and another of three millimeters between the left lower canine and the first premolar. An Egyptian predynastic skull from Naga-el-Deir had a large gap between the central incisors.

Retained deciduous teeth occurred at all periods in Nubia. The left maxillary deciduous canine of a predynastic young Nubian woman of the Middle Period, for instance, was retained directly to the outer side of the permanent canine,¹ the retention being combined with malposition of the teeth. The left upper second deciduous incisor of an adult male of the Early Dynastic Period was retained upon the palatal side. In a woman of the Byzantine Period, the permanent upper canine was displaced towards the palate and the retained deciduous canine occupied exactly the normal position. A Nubian woman of the Predynastic Period showed exactly the same condition on the left side. Retained teeth were rare in predynastic and later Egyptians, but Petrie² mentions the case of a predynastic adult with erupted wisdom teeth, whose permanent canines had been retained.

There is no evidence to show that retardation of the eruption of the permanent teeth was at all common in Egypt. Still, except in Nubia, crowding and malposition of teeth were not rare. Crowding of the teeth was observed by the author in 7 out of 156 Egyptian predynastic skulls. The left canine and the two premolars of one skull were so pressed together as to overlap; in four other cases, the crowding was limited to the front teeth, incisors and canines, and in one the crowding was evidently due to the size of the incisors which had not permitted the canines to assume their normal place.

Various malformations of teeth were observed, but as a rule they affected the roots chiefly. The roots of the first molar of a predynastic

¹ A. S. N., 208.

² A. S. N., 180.

³ A. S. N., 165.

⁴ Tarkhan I and Memphis V., 11.

skull in the Cairo Museum, for example, were fused together into a mass filling the greatly distended alveolus. Fusion of two or three roots was not rare in Alexandrian skulls, though it was seldom as marked as in the preceding case, and in Egyptian predynastic skulls abnormalities of the roots were possibly fairly common. The right mandibular canine (predynastic) had two roots in two cases, and in another skull of the same epoch both maxillary second premolars also had two roots.¹

Occasionally, abnormalities of the cusps were seen. A second upper molar had five cusps; both first molars of one mandible had six cusps, and two mandibular first molars from two different skulls had the same number. All these belonged to the Egyptian predynastic period.

The Egyptian teeth, as a rule, were very regularly planted except in cases of overcrowding; usually the "bite" was good and marked overbites were rare.

At Ras-el-Tin, overbites were present in three skulls. The maxillary and mandibular incisors and canines of the first skull did not meet. A similar defect was present in the skull of a young adult whose teeth were otherwise perfect. Lastly a skull with molars still unerupted, had overlapping central mandibular incisors.

A curious malformation was observed in the skull of a young person. The right upper canine was inclined almost directly forwards, and the neighboring premolar being in its normal position, the roots of the premolar and canine, necessarily crossing, touched one another, with chronic periostitis at the point of contact as the result. The alveolar walls of the other teeth had suffered severely from chronic rarefying periostitis, the posterior root of the maxillary right second molar, for instance, being almost completely bare. The maxillary right first molar and right second incisor had been lost during life, and there was no germ of a maxillary right third molar.

Anomalies in the region of the third molars were often met with. Pits in the alveolar process behind the third molar were seen very commonly in ancient negroid Nubians,² and also in predynastic and dynastic skulls. These pits were sometimes superficial, or formed a cavity several millimeters in depth, and it has been suggested that their frequency was connected with the roominess of the jaw. It is not unlikely that some of these alveoli actually contained teeth.

¹ It is not possible to ascertain abnormalities of the roots without taking out the teeth. This could not be done and the observations are based on teeth which had accidentally dropped out, and are therefore valueless for statistics.

² A. S. N., *l.c.*

Fourth molar teeth were found in Nubia in a few cases only.¹ An adult negroid man had fourth molars as large as normal molars, and in a negroid woman of the Byzantine period, a well formed and large fourth molar had erupted upon the right side of the upper jaw. Upon the left side there was a deep groove, like an empty alveolar cavity, which corresponded to the fully-developed tooth upon the opposite side. In another case of the anomaly, the condition was associated with a peculiar dentition: the right mandibular third molar was just visible, the corresponding left tooth was absent, and the maxillary third molar was still retained in the alveoli. On the whole it may be said that less than one per cent of predynastic and dynastic Egyptians had a fourth molar, and no case was met with in Alexandria.

Absence of the third molars on one or both sides was present in a Nubian skull from the Middle Predynastic times, which had also a retained deciduous left maxillary canine, situated just to the outer side of the permanent canine. In 156 predynastic skulls examined by the author, one or both third molars were absent in nineteen, namely: the right upper in five, the left upper in three, both uppers in seven, the right lower in one, the left lower in two, and both lowers in one. The jaws were roomy in some of these cases, so that lack of room could not be generally adduced as a reason for this anomaly. Unilateral absence of one third molar occurred in no less than seven per cent of all the adult Alexandrian skulls dating from about 300 B.C., although the jaws were large and the teeth not crowded.

Anomalies in size and position of the third molars were not at all rare in Egyptian predynastic people.

The upper third molars were noticeably smaller than the other molars in forty-five Egyptian predynastic skulls of 156, and in nineteen out of 35 mandibles. In forty-five the smallness was bilateral.

The following anomalies were also present: Case 1, left lower third molar, one root only; case 2, left lower third molar, two roots only; cases 3, 4, 5 and 6, left lower third molar, roots very small, not more than a peg; case 7, left lower third molar, two roots only. In one upper jaw, the third molars were probably impacted.

The following anomalies were met with in 112 skulls from Thebes:² First, adult female. The third upper molar was twisted on account of want of room, so that its masticating surface was turned outwards. The same alteration, though to a slighter extent, was seen in nine

¹ A. S. N., *l.c.*, 237.

² Stahr (Hermann)—*Die Rassenfrage im antiken Ägypten*, 1907.

other upper jaws. In four cases, the mandibular third molar was twisted inwards and forwards. Secondly, in several cases (exact number not stated) the alveolar border was prolonged so as to leave room for a possible fourth molar. Thirdly, in the following cases one or more third molars were absent: (a) One rudimentary left lower third molar only had erupted. (b) Male adult; no upper third molars. (c) Young male; no germs for upper third molar. (d) Male adult; no third molars. (e) Adult female; no upper third molars. (f) Adult female; no lower third molars.

Abnormalities in size were very common also. In 11 cases, the second molars were smaller than the third molars; in seven cases the third molars were larger than the first and second molars; whereas in three skulls some of the third molars were larger, and the others smaller than the other molars.

At Ras-el-Tin also, in skulls dating from the time of Cleopatra, several abnormalities of the third molars were observed. The right maxillary third molars were absent in three adults, and the corresponding teeth on the other side in three others. Moreover malpositions of these teeth were common: in two cases, the right third lower molar was planted at the base and on the inside of the ascending ramus, so that the tooth was invisible when the mandible was looked at from the side. The left third lower molar of another skull, though firmly planted, was almost horizontal. A similar curious deformation, not due to an accident, was that of a left third lower molar which was almost horizontal, being implanted at the base of and at right angles to the ascending ramus. The tooth had not been used at all for mastication, for its crown, in contrast to those of the other teeth, showed no sign of attrition. The same malformation existed in still another mandible. Lastly, the upper third molars of three middle-aged persons were noticeably smaller than the corresponding second molars.

In the Macedonians buried at Chatby, the small size of many third molars was striking.

NODULES

Enamel nodules or pearls are small enamel excrescences or droplets, occasionally met with on the roots of teeth. They are generally found upon multirrooted teeth, being situated a little below the neck, and often at the junction of two roots. On section they are seen to consist of a cone of dentine covered with a rather thick layer of enamel.

Only one such nodule was seen in the Egyptians, but as many of the molar teeth were lost, this cannot be taken as a proof of the rarity of this condition.

Dental anomalies lead at times to trouble, as illustrated by the following case: the anterior left part of the upper jaw of a Nubian Christian was in a state of very acute inflammation starting from the alveolar cavities of the front teeth. A large part of the alveolar margin was necrosed, the septic process had spread in various directions and the large anterior abscess cavity communicating freely with the antrum of Highmore also opened on the palate by a large sinus. The process had spread up the nasal duct, and to the inner wall of the left orbit. A sinus opened upon the surface of the superior maxilla behind and upon the first left premolar tooth. An irregular mass representing the conjoined roots of the front teeth occupied the large abscess cavity. The root of the interior premolar and the roots of the two teeth immediately anterior to it were joined together into one solid mass, and all had been the site of an acute septic dental disease.

III. WEAR

The intensity of attrition is said to depend largely on the nature of the food, the density of the tooth-substance, and lastly on the character of the bite. All the teeth are involved as a rule, and when a few teeth only are worn this anomalous condition is almost always due to an irregularity of the dentition.

The change proceeds slowly until the enamel has been worn away and much more speedily afterwards. As the upper incisor and canine teeth of normal persons bite somewhat in front of the lower teeth, attrition is usually more conspicuous on the lingual side of the former and on the labial side of the latter. Moreover, the slope of the upper and lower teeth towards one another produces a corresponding slant in the masticating surfaces, which increases as the attrition gets more pronounced; the worn-down crowns of the upper incisors, for instance, are usually inclined obliquely towards the lingual side, whereas those of the lower incisors tend to slope in the opposite direction.

Nowadays, attrition is a characteristic of people living on raw, fibrous, vegetable food (Egyptian fellaheen), of old people and of deciduous teeth in their last stages, and great individual differences exist both in its mode and degree. Should the food consist of hard seeds, roots or tough meat, attrition is most marked on the lingual side of the upper, and the labial side of the lower teeth. In people living

on rich nitrogenous food, the pulp is generally replaced by secondary dentine and the tooth is often worn down to the neck, without the formation of an alveolar abscess; whereas, when the food is deficient, inflammation, abscesses and extensive resorption of the alveoli are common.

There are generally recognized four degrees of attrition.¹ In the first degree the enamel is abraded without obliteration of the cusps or exposure of the dentine. The second is characterized by disappearance of the cusps and partial exposure of the dentine. When the height of the tooth is reduced still further the third stage is reached, characterized by a complete dentine exposure, and in the fourth stage, the wear extends to the neck, the crown having entirely disappeared. It is however often difficult to place a tooth in any of these divisions, as different parts of the masticating surface of one tooth may exhibit more or less intense stages of attrition. A first molar, for instance, may be worn down to the gums on the labial or lingual side, but the rest of its crown may be almost normal. In this paper no use will be made of any classification.

Ancient peoples, like uncivilized modern ones, used their teeth for many purposes, which may account for some severe lesions, in which connection may be recalled the professional attrition of the teeth of cigar makers, seamstresses, pipe smokers, or that produced by the clasps of artificial teeth.

Attrition was very common in the teeth of ancient peoples of Europe, Asia and Africa. The human teeth found in the Thames mud at Tilbury, for instance, showed this change to a very marked extent. The lesions in the teeth of the Tilbury skull have been observed in other ancient British crania, *e.g.* in the earliest skull lately found in Kent. The severity of the attrition in the prehistoric teeth found at Caithness and elsewhere varies somewhat, it is said, according to period. The teeth of the skull found in the brick-earth deposit of Halling, Kent, had been ground until only half the crown remained, and it has been mentioned that both in the Tilbury and Halling skulls, the teeth were not lost through the modern disease of caries, but by exposure of the pulp cavities with the consequent formation of abscesses at the root of the teeth. Certain it is that in late Palæolithic and early Neolithic times tooth wear and alveolar abscesses were not uncommon.²

¹ See Broca (P.)—Instructions relatives à l'étude anthropologique du système dentaire. *Bull. Soc. Anthr.*, Paris, 1879, ii, 149.

² Cook (W. H.)—On the discovery of a Human Skeleton in a brick-earth deposit in

The teeth of the Bronze Age are stated not to be worn as deeply as those of the Saxon or Middle English period. A very characteristic first to second degree attrition disfigures the teeth of the Heidelberg as well as the Neanderthal jaws, and a wear of a more pronounced nature is seen in the jaws of Gibraltar and Chapelle aux Saints.

In the teeth of ancient Germans, attrition beyond a certain age was the rule. The prehistoric skulls from Reiherwerder² and Halberstadt³ to mention only those more lately discovered—show a marked degree of wear. Similar lesions are noticeable in the teeth of ancient Frenchmen. The teeth of the skeleton of Chancelade, for instance, dating from near the end of the Quaternary period are worn down, while numberless other examples of attrition are mentioned in French memoirs. Wear is also well marked in the teeth of the Most or Brux skull of Bohemia, in the Ochoz jaw of Moravia, in the older individuals of the Maška's Moravian mammoth hunters, and in still other old specimens from the central and other parts of Europe. The teeth of prehistoric children even show attrition in some instances, and the same is well marked in young adults from La Chaumière,¹ Cro-Magnon, Montréjean, Barma Grande,² etc. The skulls from Swiss pile-dwellings show like alterations.³

The teeth of ancient Egyptians were frequently worn down in a characteristic fashion. The most prominent parts of the crown, the cusps, were the first to vanish, the masticating surfaces being ground flat. This stage, however, was seen in ancient Egyptians only exceptionally, as even in young adults attrition had usually passed this stage. At this early period, in the maxilla, a thin groove, not more than 1 mm. wide and 5 mm. deep formed along the whole length of the cutting surface of the incisors; and the crown of the canine was hollowed into an irregular, roughly lozenge-shaped cavity, similar to that which had formed by that time on the labial side of the crown of the neighboring premolar. Very often also, the lingual border of the valley of the River Medway at Halling, Kent, Keith (A.)—Report on the human and animal remains found at Halling, Kent—*J. Anthr. Inst.*, 1914, xlv.

¹ Virchow (Hans)—Die Schädel von Reiherwerder—*Prähist. Zeitschr.*, 1910, ii, 78.

² Schliz (A.)—Untersuchungsbericht über drei Schädel aus dem Halberstädter Museum—*Prähist. Zeitschr.*, 1912, iv, 377.

³ Quatrefage et Hamy's *Crania Ethnica*, 49, 114; also French anthropological periodicals.

⁴ Verneau (R.)—L'homme de la Barma Grande. 1893.

⁵ Baudouin (Marcel)—De l'usure des dents chez l'homme du paléolithique inférieure et moyen. *Arch. Prov. d. Chirur.*, xxi, 66.

the canine was worn down somewhat obliquely, even when the enamel was apparently intact.

At that stage, two shallow cavities separated by a bridge of strong, normal dentine had formed on the masticating surfaces of upper premolars, the bow- or half-moon shaped cavity on the lingual side being always the deeper of the two, with its convex border towards the proximal side. The other, shallower cavity, was irregularly lozenge-shaped.

The masticating surfaces of the first upper molars with few exceptions were the chief sufferers, and the cavities produced by attrition were very irregular and not easily described, as may be seen from the appended photographs. The cavity first formed was deeper near the lingual and proximal borders close to the second premolar, and the attrition of these teeth was conspicuous even before the second molar tooth had erupted. Later on, the changes in the second molar teeth might still be slight when the attrition of the first molars was already far advanced. The masticating surfaces of this tooth were ground flat or a small bow-shaped cavity occupied the lingual side, with another just showing close to it, and at this stage the third molar tooth was still practically normal.

A more advanced degree of wear was characterized by the formation of a large cavity in the masticating surfaces of all the teeth. In the incisors, the single cavity previously described became deeper; in the other teeth, the bridge of dentine separating the two cavities previously formed was worn away and the cavities coalesced, but the attrition of the first molars was always more marked than that of the other teeth.

The changes in the lower teeth resembled those in the upper teeth, save that the cavities formed in the crowns were deeper on the labial side.

As attrition proceeded, the dentine surrounding the cavities gradually disappeared, the crown was worn deeper and deeper, until the masticating surfaces were just above the level of the gums. The pulp cavity was then often widely open and unprotected, and at the same time the masticating surfaces, sloping more and more, formed an acute angle with the fangs.

The attrition of the posterior half or two-thirds of the masticating surface of the third molar was often peculiar in so far that the worn surface looked directly backwards and more or less downwards. The same irregularity was often seen in the second molar when the third

molar had fallen out, and was conspicuous in any tooth which had no immediate neighbor behind it. Other irregularities in attrition, caused by irregularities in the dentition need not be discussed here, as they were of no special significance. The general health of the teeth was not necessarily affected by attrition, and, in some ancient Egyptians the teeth, although worn down to the roots, were healthy otherwise. This however, was the exception rather than the rule for, as will be shown later, alveolar and perialveolar abscesses were often unmistakably caused by infection through teeth opened by attrition.

In Egypt and Nubia attrition of the teeth has been the rule from the earliest times to the present. Predynastic Nubian teeth were levelled down uniformly, whereas in more modern times,¹ it is said, a deep cavity forms in the centres of the crowns, and hence a distinction is made between the mode of attrition in ancient and that in more modern Nubians. The distinction cannot be proved as the formation of a central cavity is only one of the stages of attrition, but nevertheless, the study of several hundreds of skulls did suggest that the teeth were ground down evenly in some cases, whereas in others attrition was characterized by the formation of deep cavities, surrounded by a ring of strong dentine.

At Merowe in Nubia, most of the teeth were ground down, and although attrition had evidently progressed rapidly in early youth, yet it was never as marked as in predynastic skulls or in those of modern Egyptians. The change had apparently taken place in old people at a much slower rate than in the young, and probably it had sometimes stopped altogether in the old.

In Egypt the teeth of people of the Ancient, Middle and New Empires of Greek, Roman and early Coptic times, were all more or less affected by attrition. The change was conspicuous in people of every class—in the cemeteries of common folks, in the priests of Deir-el-Bahari, in the rich Alexandrians of Greek and Roman times, and even in some royal personages. The teeth of Rameses II, for instance, show marked attrition.²

Universal though attrition was, its severity appeared to vary. It was perhaps most marked in Upper Egypt, including Nubia, and in very ancient predynastic times, and least conspicuous in Lower Egypt among the Greek, Roman and Egyptian populations of Alexand-

¹ A. S. N., 279.

² Observations relevées sur quelques momies royales d'Égypte. *Bull. Soc. Anthr.*, Paris, 1886, ix, 578-590.

ria. Whereas, for instance, the teeth of even young subjects from predynastic Egypt and Nubia were much worn, those from the young people buried at Kom-el-Shougafa, Ras-el-Tin and Chatby and its neighborhood were often almost, if not quite, normal. The crowns of the teeth of Nubian or Upper Egyptian adults from predynastic times were often level with the gums, whereas this was never observed in Alexandrians, not even among old people.

The degree of attrition has been used by anthropologists as a guide in the estimation of age, but there are several points which must be remembered before definite conclusions can be drawn in this respect, the most important of which is that the condition is sometimes very pronounced in young people. The attrition of the teeth of the *Homo Aurignacensis* was more pronounced in the second molar than in the third, and the lesion therefore had been produced in the period between the eruption of the second and that of the third molar. Similarly, the permanent teeth of young subjects at Cro-Magnon, Montréjéan and La Chaumière were worn before the eruption of the third molars, and the cusps of the deciduous premolars of neolithic people from Vendrest in the Vendée were worn at five years of age, the lesion being very pronounced in six-year-old children. The attrition of the posterior premolars, affecting the external cusps chiefly, began a little later in life. In ancient Germany also, early attrition was the rule: at Adlerberg, for instance, the molars of two young people of the Bronze Age were much worn, although the third molars had not yet emerged. Among the ancient Nubians and Sudanese, the process started early in life and the rapidity of its progress could be estimated approximately. In several mandibles examined by me at Fares and Merowe, in which the canines were just showing through, the first lower molars were already much worn. In about three years, therefore, most of the mischief had been done. Similarly the crown of the second premolar was ground down very deeply in the interval between its eruption and that of the third molars. Further, the lesions may be not more advanced in the teeth of old people than in those who die young. The teeth of modern Egyptians are sometimes worn to the gums before the age of 25, but I have seen Egyptians more than 50 years old with teeth showing little trace of wear. This may be due to the character of the food, but the impression gained from the examination of hundreds of skulls is that attrition in these people proceeded very rapidly up to the age of 25 or so, and then became almost completely arrested. This is not in accord with observations on other peoples.

The reason for the severe attrition of Ancient Egyptian teeth was doubtless due to the food. The Egyptians were nicknamed "eaters of bread," and to them as to the Hebrews, bread was synonymous with food. It was made from spelt, bearded wheat or barley. Cereals were cultivated from early times, though opinions may differ as to which at different periods was most used for breadmaking. Flour was prepared already in the predynastic period, by grinding grain between two stones or pounding it in a mortar. At a later period a handmill, and later still a mill driven by machinery replaced the more primitive apparatus. The specimens of old Egyptian bread which I have examined consist of a very coarse paste usually containing a large amount of husks and some straw even, together with coarse fragments of unbroken wheat or barley grain. Undoubtedly this bread did not improve the masticating surfaces, even if it did contain plenty of fibrous material to clean the interstices of the teeth. One cannot help wondering whether the barley and wheat were cleaner than the native cereals, contaminated with sand and earth, now sold in Egyptian markets; in any case, the pounding in a mortar or the grinding between stones necessarily detached many fine stone particles, which mixed with the dough escaped detection, but which chewed every day certainly did not improve the crowns of the teeth.

The contents of the intestines of dried predynastic bodies and of mummies from dynastic to Coptic periods, prove the considerable quantity of coarse vegetable material—barley husks chiefly—that was eaten, and this observation together with the composition of the samples of bread examined by the writer, explains the attrition of the dental crowns. The teeth of soldiers for instance, must have been severely tried by their daily ration of four pounds of bread.

The teeth were not improved by the mastication of the roots of marshy plants, which raw or cooked, the poorer Egyptians—and possibly the richer—ate in large quantities. Indeed, many of the children of the poorer class were brought up on them. The chief fruit eaten by the Egyptian consisted of grapes, figs, dates, dates from the düm-palm, pomegranates, melons, balanites *Aegyptiaca*, paliurus, carobs, olives, apricots (?), and the seeds of marshy plants. With the exception of dates, the paliurus and the seeds of aquatic plants, the fruit eaten had but little or no effect on the teeth, for although the rich had extensive fruit gardens, Egypt has never been a great fruit growing country and the Egyptians of the poorer classes, like the present fellah, probably tasted little fruit except dates and melons. It may be remarked that dates are not unfrequently very stringy.

Attrition was intensified by the consumption of raw vegetables. Lentils, beans, artichokes, asparagus, beetroot, and cabbages doubtless were cooked before being served up; but on the other hand onions, cucumbers, garlic, radishes, turnips etc. were eaten raw with bread, as is done now. The six small cucumbers which at the proper season an Egyptian fellah takes for his breakfast, make fine exercise for his masticating apparatus and doubtless provoke a good flow of saliva, but they do not improve the crowns of his teeth.

The diet certainly was not wholly vegetarian, for the predynastic refuse heaps of El-Toukh have given up remnants of many animals that had served for food. Also, cattle were kept as far back as Egyptian civilization can be traced, and many wild animals and birds were either hunted or kept in captivity and artificially fattened. The Nile and its canals were inexhaustible reservoirs of fish; salted and pickled fish was a favorite article of food and exported to foreign countries. It would have been interesting to know how the meat was cooked, whether it was eaten well done or underdone, and whether in fact, it helped in wearing down the teeth. The diet sheets which have come down to us point to a mixed diet having been the rule with people in government employment, and with the better class. Under Menhuhotep III¹ each soldier of an expeditionary corps into the desert received two jars of water and twenty small biscuit-like loaves. In the XIX dynasty, under Seti I² "His Majesty increased that which was furnished to the army in ointment, ox-flesh, fish and plentiful vegetables without limit. Every man among them had four debens (about four pounds) of bread daily, two bundles of vegetables, a roast of flesh and two linen garments monthly." The king's messengers had "good bread, ox-flesh, wine, sweet oil, fat, honey, figs, fish and vegetables every day."

At Silsileh,³ every one of the thousand workmen employed in the sandstone quarries received daily nearly four pounds of bread, two bundles of vegetables and a roast of meat. The king's bodyguard⁴ was given in addition "to each five minæ in weight of baked bread, two minæ of beef and four arysters of wine."

The following inscription copied from the tomb of Beha in the XVIII dynasty⁵ refers to the diet of children: "The children were—great and

¹ Hammamat Inscriptions of Henu.

² Assuan Inscription.

³ Breasted—History of Egypt, 414.

⁴ Herod., II, 163.

⁵ Brugsch—Egypt under the Paraohs, 121.

small—sixty. . . . They all consumed 120 ephahs of durra, the milk of 3 cows, 52 goats and 9 she-asses, a hin of balsam and 2 jars of oil." According to this, bread of durra, milk and oil were the children's diet. The children of well-to-do people who went to school carried their daily food, bread and oil with them, but the poorer people's children were not so spoilt: "They give¹ them very simple cooked foods which can be grilled before the fire, roots, and roots of plants growing in marshes, sometimes raw and sometimes roasted." The Alexandrians of course, ate the native dishes and all the luxurious dishes of Rome and Greece.

The attrition of the Egyptian teeth, the contents of the refuse heaps, the intestinal contents, the offerings of food in tombs, the mural decorations and the literary evidence all point to a mixed diet, of which coarse bread and vegetables formed the chief constituents. To explain the attrition it is not necessary to assume, as has been done, that the Egyptians ate earth or that the food was contaminated with sand.

IV. CARIES

Cariou human teeth from ancient remains have been discovered in so many places that it is legitimate to doubt whether there was ever an epoch when the human species was not cursed by toothache. The population of England has certainly suffered from it for thousands of years. Of 69 skulls from Wiltshire tumuli,² dating from the stone age, two had carious teeth. The people buried in the tumuli, a pastoral and agricultural race, lived by the chase and "their habits were barbarous." Nine cases of caries, namely 4 on occluding and 5 on approximal surfaces, were found in 44 skulls of a similar group inhabiting more northern districts of England. In the people of a later race (Bronze period), the agricultural population referred to by Caesar in his Commentaries, there were 6 cases of caries in 32 skulls, 5 on approximal and 1 on occluding surfaces. The teeth of Romans in England were not unfrequently carious; of 143 skulls, about 32 showed signs of caries, and in one instance the disease was extensive. In 76 skulls of the Anglo-Saxon period, caries was present in 15.

The painful ailment was common in the inhabitants of ancient France. At least two skulls from Aurignac,³ several crania of the Furfooz, La Truchère and Aurignac races,⁴ a skull from the cavern of

¹ Diodorus Siculus, I, 93.

² Mummery (J. R.), l.c.

³ Quatrefage et Hamy's *Crania Ethnica*, 104.

⁴ *Ibid.*

Engilhoul,¹ a prehistoric skull from the Carrière Hélié at Grenoble,² skulls from dolmens (Billancourt, Moulin-Quignon),³ all these had carious teeth, sometimes associated with extensive lesions.

It is estimated, but on what appears to me insufficient data, that only about 1.5 per cent of the people found in the neolithic ossarium of Bagoges en Pareds had carious teeth. At Vendrest, in the Vendée, of 1,948 teeth collected in a neolithic ossarium, 49 molars and 11 premolars were carious, but no incisors or canines. The dental pulp of 36 was attacked; in 25 there was slight caries of the neck only; and in one the caries was limited to the masticating surface of a wisdom tooth. Of 317 deciduous teeth, two molars showed slight caries in the neighborhood of the neck. From these observations the conclusion was drawn that caries was neither common nor severe in that period. A neolithic burial⁴ contained a carious tooth pierced for suspension.

Carious teeth have been discovered in the Grotto of Mayrannes (Bronze Age),⁵ in dolmens of the Gard, of Saint Vallier de Thoy (Rivière), in the grottos of Albarée (Alpes Maritimes), in the Grotto of La Marthe, and at Carzy la Rouet. The Roman settlers in Gaul suffered, for the right upper second premolar and second molar of a Roman skull were carious, and the left lower second premolar and all the molars had been shed prematurely.

Caries worried the ancient Germans also. A skull from the 6th–10th century B.C. unearthed at Reiherwerder, had 4 carious teeth out of the 5 remaining; and the disease had probably been extensive, for the absorption of the alveoli proved that the missing teeth had been lost during life. Other examples were discovered in the Ruhr Valley, where several teeth from 32—or possibly 34—cavern burials⁶ were carious. Human teeth dating from the La Tène period from Zeiningen⁷ and Worms am Rhein,⁸ showed similar changes. Ancient

¹ Hamy (E. T.)—Note sur les ossements humains fossiles de la seconde caverne d'Engilhoul près Liège. *Bull. Soc. Anthr.*, Paris, 1871, vi, 370–386.

² Quatrefages et Hamy's *Crania Ethnica*, 120.

³ *Ibid.*, Pl. xcvi–3, 112.

⁴ Camus—*L'Homme préhist.*, 1908, vi, 326.

⁵ Cotta (Ch.)—La carie dentaire et l'alimentation dans la Provence préhistorique. *L'Homme préhist.*, 1905, iii, 74.

⁶ Carthaus—Über die Ausgrabungen in der Valedahöhle unweit Velmede im oberen Ruhrtale. *Prähist. Zeitschr.*, 1911, iii, 137.

⁷ Hölder—Untersuchungen über die Skeletteffunden in den Vorrömischen Hügelgräbern Württemberg's und Hohenzollern's Fundberichte aus Schwaben. *Ibid.*, 1895, ii.

⁸ Bartels (P.)—Über Schädel u. Skeletteffunde d. früheren Bronzezeit aus der Umgebung von Worms am Rhein. *Ibid.*, 1912, iv.

Denmark,¹ Sweden, Norway and Italy² were certainly not free from the disease.

From the earliest to the present times, caries has attacked human teeth in Nubia, Upper and Lower Egypt, and yet, from the data at our command, it is almost impossible to form an opinion regarding the incidence of the ailment during successive centuries. One observer whose opinion certainly carries great weight, expresses himself as follows:³ "Both in Nubia and Egypt the ordinary form of caries is exceedingly rare in predynastic and protodynastic people, and among the poorer classes it never became at all common until modern times. . . . Dental caries became common as soon as people learned luxury. In the cemetery of the time of the Ancient Empire, excavated by the Hearst expedition at the Giza pyramids, more than 500 skeletons of aristocrats of the time of the pyramid builders were brought to light, and in these bodies I found that tarter formation, dental caries and alveolar abscesses were at least as common as they are in modern Europe to-day. And at every subsequent period of Egyptian history one finds the same thing—the wide prevalence of every form of dental disease among the wealthy people of luxurious diet, and the relative immunity from it among the poorer people who lived mainly on a coarse uncooked diet.

"Among the Biga people of Nubia in whom dental caries appeared to be very prevalent, everything points to the fact that the people buried at Biga were not leading the life of their neighbors. The abundance of clothes and the number of wine-jars suggest a life of luxury—and gout is not engendered by the ordinary fare of Nubia. This all means that dental caries in the Early Christians of Biga was due to the operation of the same factors which are supposed to be causally related to it elsewhere, namely, an improper diet. This conclusion is borne out by the extreme rarity of dental caries in children throughout these Egyptian and Nubian cemeteries, because they lived on the food supplied by nature and not that provided by the chemist."

That the frequency of caries in Nubia and Egypt increased gradually from predynastic to Christian times and later, is undoubtedly the first impression produced by the examination of ancient Egyptian skulls, and yet no observer has brought forward any satisfactory statistical evidence to support it. An estimation of the incidence of caries in any given community based on the examination of skulls is very

¹ Nielsen (H. A.)—*Danemark. Arch. f. Gesch. d. Med.*, iv, 377.

² Italy. Quatrefages et Hamy's *Crania Ethnica*, p. xci, fig. 3.

³ Elliot Smith, *A. S. N.*, ii.

difficult always, and not infrequently well nigh impossible. Many teeth invariably disappear during excavations, and there is every reason to suppose that some of these teeth were carious, although they never figure as such in statistics. The incidence of caries therefore, is always estimated too low.

An attempt was made to estimate the number of cases of caries in the large collection of skulls in the Museum of the Medical School of Cairo, which contained a large number of predynastic skulls, others dating from the IV to the XII dynasties, others again from the time of the pyramid builders at Gizeh, and from Ptolemaic and Coptic times. The result was worth nothing; firstly, because it was impossible to diagnose why a missing tooth had been lost during life, and secondly on account of the enormous number of teeth which had fallen out after death. In the case of the skulls from Gizah and the dynastic skulls, not even an approximate idea regarding the incidence of caries could be formed.

The field notes on cemeteries in Nubia prove that the disease existed in predynastic times, and among the archaic Nubians. Some of the lesions connected with caries in Nubians from the middle of the Ancient Empire were very severe. The skull of an old man, for instance, had extremely carious teeth, with alveolar abscesses at the roots of eight upper and eight lower teeth.¹ In other skulls of the same epoch, caries was limited to one or two teeth.

No less severe were occasionally the lesions in more modern times, in the later B group for instance.² The front teeth of a man from this period were much worn, the stumps of the upper teeth and upper right second premolar were carious, and all the lower teeth behind the premolars had been lost during life, with the exception of the carious stumps of the right molars. A Nubian woman from the Middle Empire with teeth very much worn and carious had extensive inflammation of the left mandible spreading from the alveoli. During the Roman, Christian and Byzantine periods in Nubia the disease was active and the co-existent lesions sometimes very severe. The skull of a middle-aged Christian woman³ was disfigured by a dental abscess round the roots of the right upper second premolar and of the first molar, which opened on the palate and face, and there were also small abscesses round other carious teeth. A very old woman⁴ had

¹ A. S. N., 75.

² A. S. N., 118.

³ A. S. N., 42.

⁴ *Ibid.*, 52.

lost all her teeth except one carious upper stump and four similar fragments in the lower jaw. Other skulls had evidently lost most of their teeth from the disease, as several of the remaining teeth were carious.

The teeth of prehistoric skulls from Naga-ed-Deir in Egypt were not infrequently carious, but as a rule, there were not more than two or at most three carious teeth in any one skull or mandible. Lesions secondary to caries were usually absent, and in one case only was secondary disease of the maxilla noted.

I attempted to tabulate the cases of dental disease in Nubia according to the notes of the Archaeological Survey, and the table so prepared certainly showed a rise in the number of cases of caries and dental disease after Ptolemaic times. Of 72 skulls of the B group, for instance, 20 per cent had lost some teeth and four had carious teeth, whereas of 165 skulls dating from a time after the Ptolemaic period 74 per cent had missing and 28 per cent had carious teeth. At first sight only one conclusion appears possible, namely, that dental disease and especially caries increased in frequency in the 2,000 odd years between the B group and the beginning of the Christian era.

On examining the notes more closely however, the incidence of dental disease and caries was found to have remained practically stationary for a long period and then to have risen suddenly to an unprecedented level after Ptolemaic times. When seeking an explanation for this startling fact one was led to wonder, as Wood Jones had done, whether this extraordinary rise was not due to any immigration of people who accommodated themselves badly to their new conditions of life and their new food.

The facts are as follows: The predynastic and the A group of dynastic people in Nubia were the old Egyptian race with little admixture of negro. The percentage of black blood increased slightly in the people of the B period and still more in the C group. The New Empire saw a considerable influx of Egyptians until, later on¹ the Nubian element again increased. Groups of negroid people then began to make their appearance (Group E). These have been met with in Ptolemaic and even in some Roman cemeteries of Nubia, and some possibly emigrated or were brought as slaves into Egypt. The race inhabiting Nubia therefore was fairly pure at first, but gradually became more and more mixed. The intermixture increased still more after the Ptolemaic period, especially among the Biga people who, as had been noted,

¹ A. S. N., 36.

suffered much from dental disease, as 43 out of 86 skulls had missing teeth and 16 had caries. Most of the Biga people, among whom the incidence of caries was highest, were immigrants, perhaps from Asia Minor, who intermarried with Nubian women together with a few Egyptians and many Sudanese. It is considered probable that at the time of their deaths these immigrants had not been settled in the neighborhood for more than 35 to 40 years. A comparison between a race of immigrants and dynastic or predynastic Nubians must lead to fallacious conclusions because the age, habits and perhaps the cookery of the two classes of people, were probably very different.

It is not necessary to assume that the increase in caries and dental disease among the Biga people was the just punishment for a more luxurious mode of living. The food, to judge from the attrition of the teeth which is noted in several observations, was fairly coarse, for attrition is not the characteristic result of soft food, the alleged cause of caries. Those people probably drank wine, but wine was used in Egypt and Nubia from the earliest times, vineyards existed in both countries, and Nubian beer had a great name long before the Christian epoch, indeed is mentioned in so ancient a book as the Liturgy of Funerary Offerings. Neither is the fact that one case of gout was discovered a proof of luxurious living. There is such a thing as poor man's gout. Uric acid calculi have been taken from Egyptian bodies dating from the III dynasty and possibly earlier times, and indeed, occur among herbivorous animals. When these foreign immigrants were excluded, the incidence of dental disease was seen to vary considerably in different cemeteries during Ptolemaic and Christian times.

The author's study of the predynastic skulls in Egypt showed that caries and dental disease were present from very early times. The results of the examination of these skulls are as follows: *Maxillæ*: Out of 156 specimens, the number with missing or carious teeth was 54, or 35 per cent; the number with carious teeth, 32, or 20 per cent. *Mandibles*: 95 specimens; number with missing or carious teeth, 21, or 20 per cent; number with carious teeth, 15, or 15 per cent. A little less than one-half of the maxillæ of prehistoric Egyptians and four-fifths of the mandibles had not lost any teeth and showed no decay, which is a remarkably good record.

These figures taken by themselves, however, would give a wrong impression regarding the prevalence of dental disease in predynastic times, for 60 per cent at least of all maxillæ and mandibles were scarred with lesions of chronic suppurative periodontitis. Forty-five skulls

had abscesses connected with the maxillary teeth, of which 12 were associated with caries, 10 with missing teeth, 5 with both defects, and in 28 skulls with abscesses no teeth were missing and there was no caries. Eighty-two upper jaws out of 156, or 53 per cent, therefore, had gross pathological lesions of or connected with the teeth. Of the 95 mandibles, 12 had dental abscesses. These abscesses were associated with missing teeth in two cases, and with carious teeth in two others. Twenty-nine per cent, therefore, showed gross lesions of dental disease.¹

The following data give the incidence of carious and missing teeth according to their position:

Upper: M 1, M 3, M 2, I, Pm 2, Pm 1, C, I 2;

Lower: M 2, M 3, M 1, Pm 2, Pm 1, I, I 2 C.

These figures prove clearly that the molars, the first molars especially, were in the old Egyptians the teeth most prone to caries, and this observation agrees with the results of modern statistics regarding the incidence of caries in individual teeth, statistics nearly always derived from records of extractions.

Statistics from Vienna based on examination and not on extractions, do not give the same results, and according to them the liability of individual maxillary teeth to caries stands in the following order:

I 1, M 1, I 2, Pm 1, M 2, Pm 2, C, M 3;

and in the mandible:

M 1, M 2, Pm 2, Pm 1, M 3, C, I 2, I 1.

On the whole, our data correspond fairly well with the statistics that have been based on the extraction of teeth, which are:

Maxillary:

M 1, M 3, M 2, I 1, Pm 2, Pm 2, Pm 1, C, I 2.

Mandible:

M 2, M 3, M 1, Pm 2, Pm 1, I 2, C, and I 1.

The following were the results obtained by the author's examination of skulls in the predynastic to I dynasty cemeteries of Tourah near Cairo:²

¹ The cases of chronic suppurative periodontitis without abscesses are not counted.

² Derry (D. E.) in Hermann Junker—Bericht über die Gräbnungen und dem Friedhof in Turah. *Denkschr. Ac. Wiss.*, Wien, 1912, lvi.

Of 29 skulls three belonged to children not more than 16 years of age. Seven of the remaining skulls were more or less broken and parts of the dentition were missing; in two others some teeth were broken away in the first specimen and the teeth had dropped out after death in the second. There was no caries in any skull: a very striking fact, for, even making allowances for the number of skulls more or less damaged, and for the youth of many of the cases, a series of 17 skulls free from caries could not easily be discovered anywhere in collections of modern skulls. On the other hand, lesions of periodontal disease, abscesses, loosening of teeth etc. were present in 10 of the complete skulls and one skull had lost many teeth in post-mortem.

Caries was present also in some of the predynastic skulls at Dahshur,¹ and in one of them the only remains of the teeth consisted of a few worn and carious stumps. In the same locality² the Princess Nour Hotep, who was about 45 years old at the time of her death, had two carious first molars, and the alveoli of these were inflamed.

An examination of skulls from the XXV-XXVI dynasty at Merowe, in the Sudan, and of crania dating from the Meroitic Kingdom of Faras, revealed the presence of caries in 12 per cent of the skulls only. Owing to the pressure of time, however, the examination at the graveside was rather superficial, and the crowns of a large number of teeth had been broken off, while numerous teeth had been lost after death. Of the 36 skulls and fragments of mandibles from Faras and Merowe which were taken to Alexandria for examination all but two had one or more carious teeth. The crowns as a rule were not affected, the carious hole being in the neck of the tooth.

Of 110 ancient though not accurately dated skulls from Thebes,³ 12 only had carious teeth, and in two cases only a very small part of the tooth was affected. It must be noted however that many of these skulls also had lost a number of teeth during life, of which some may have been carious.

Several aristocrats, whose mummies are now in the Cairo Museum, were martyrs to caries during life. All the maxillary teeth of a woman, for instance (princess Maritamón, XII-XIII dynasty, about 1900 B.C.), were carious with the exception of the canine and the third molar, and the first and second molars were reduced to mere stumps. An aged court lady (XVIII dynasty, about 1400 B.C.) had a carious

¹ de Morgan—*Les origines de l'Égypte*, 280.

² *Ibid.*, 148.

³ Stahr (Hermann)—*Die Rassenfrage in Aegypten*. 4^e, Berl., 1907.

upper first molar, and alveolar abscesses at the root of the neighboring molar.

Nineteen hundred years ago, caries also was by no means rare in the Egyptian population of Alexandria, and it attacked children and young adults also. A child with complete deciduous dentition, had deep caries of the first upper right molar and neighboring premolar, the crowns of these teeth being completely destroyed, and traces of supuration were to be seen round the maxillary molars on both sides. A young adult, with wisdom teeth still unerupted, showed caries of both first upper molars on the approximal side. The right second upper molar of another young woman was so deeply carious that the whole had disappeared.

Some cases of caries in adults were very severe. A male, for instance, between 40 and 50 years old, had lost the left upper first molar and neighboring premolar during life, the alveolus of the latter showing an external fistulous opening about 2 mm. wide. The dental canal of the right second upper premolar had been opened by attrition, as the right first upper molar was also carious on its approximal side. Both teeth were covered with thick tarter, and, the buccal border having been completely absorbed, both alveoli communicated with the mouth by a wide aperture. Attrition, caries and rarefying periostitis had all helped to produce these lesions.

The Copts of Antinoë must often have suffered acutely from toothache, as may be seen from the following notes on the teeth of these people:

1. Adult man, probably about 45 years old, had lost the right first upper molar and second premolar, together with the left first upper molar. In the mandible the right second premolar and first molar together with the left molar had been shed during life. The left lower second premolar was carious on distal side.

2. Adult woman, probably about 26 years old. The lower third molars were present, whereas the corresponding upper teeth had not emerged. The right lower first molars and left molars and premolars were shed during life. There was extensive caries of the posterior part of the left lower second molar extending almost to the fang, and of the right second and third molars at the point of contact. The crowns showed but slight attrition.

3. Man, adult, but not aged, probably about 30 years old. Teeth missing—upper, all right premolars and molars, left second premolar and third molars; lower—right second molar, left molars and pre-

molars. Second right upper incisor carious; region occupied by left first and second upper molars hollowed out into a cavity with deeply pitted floor, measuring 15 mm. from before backwards and 12 mm. from side to side; outer wall of the alveolus of the first molar completely gone.

Very startling is the statement¹ that in Nubia caries was not met with in the deciduous teeth of children of the archaic period—that it did not make its appearance until the Christian era, and that, even in Christian children, the disease was very rarely seen. The observation though interesting does not justify the conclusions which have been based on it. In the first place many of the infantile skulls that have been discovered were those of newly born children or babies, in whom for obvious reasons caries could not have occurred, and in Egypt as in Nubia the number of children's skeletons which have been studied is so small as to be, in my opinion, almost useless for forming an estimate regarding the incidence of infantile caries, or of any other infantile disease. In Nubian adolescents and adults extensive lesions, directly or indirectly due to caries, were not rare, especially in Christian times. A Coptic boy of Nubia,² 17 years old, had a large abscess cavity at the root of the right upper second molar on the outer side; the right second lower bicuspid also was carious, and the right and second molars, together with their alveoli had disappeared; the left second lower molar was represented by a carious stump only. A young woman from the Roman period had worn and carious teeth. A young Christian woman had lost seven teeth during life, and the right upper second incisors together with the right lower second premolar, were carious; another young Christian woman had caries of several upper teeth; and several more young early Christians suffered extensively from caries.

The teeth of the Macedonian soldiers buried at Chatby were not often attacked with caries and in no case was this found to have been very severe. Here also however the same difficulty presented itself in estimating the exact percentage of dental disease owing to the fact that many of the teeth had dropped out after death and could not be found, and therefore only the teeth of which the alveoli showed partial or complete absorption were considered as having been lost through disease.

¹ *A. S. N.*, 279.

² *A. S. N.*, iii, 48.

IV. OTHER LESIONS

Alveolar and perialveolar abscesses have been frequently observed in ancient skulls in England, Germany and France, and have been usually attributed to infection through dental canals opened by attrition. In England, for instance, many teeth of a skeleton from Halling (Kent), dating from late palaeolithic or early neolithic times, had been lost apparently through exposure of the pulp cavities, which had led to the formation of abscesses at the roots.¹ At Zairingen in Germany, a skull from the Grotto of Ale had an abscess, apparently due to the opening up by attrition of the dental pulp of the left upper third molar. Many similar cases have been discovered in French ossaria—in the Vendée for instance—and in Denmark, Sweden, Norway, Australia and elsewhere.

Dental abscesses were common in every cemetery of Nubia and Egypt. An ancient Nubian² for instance, had several alveolar abscesses supposed to have resulted from infection through pulp cavities opened by attrition, and most of the upper as well as lower teeth had been lost. Another predynastic man³ had only a few teeth left which were greatly worn and had abscess cavities at their roots; the right side of his face showed "abundant inflammatory disease" probably connected with the teeth. Again, well worn teeth with five abscesses at their roots were found in an archaic Nubian⁴ who died some time between the ages of 25 and 40; a young Christian⁵ woman also had an abscess at the roots of the left upper third molar, and the pus had perforated into the antrum.

Of 100 maxillary abscesses in predynastic people, 22 were round the first molars; 17 were round the second molars; 15 were round the median incisor; 11 were round the posterior premolars; 10 were round the anterior premolars; nine were round the canines; 9 round the third molars; 6 round the lateral incisors, and the position of one was doubtful.

Of 35 mandibular abscesses in the same people, 13 were round the first molars; 6 were round the canines; 5 were round the second molars; four were round the median incisors; 3 were round the posterior premolars; 3 were round the third molars and 1 was round the anterior premolars.

¹ Keith (A.)—*J. Anthr. Inst.*, 1914, XLIV.

² *A. S. N.*, 117.

³ *Ibid.*, 127.

⁴ *A. S. N.*, 127.

⁵ *Ibid.*

The abscesses were often multiple. Thus, the jaw of a Nubian female was riddled with dental abscesses, and in another such purulent collections had developed round the second and third molars on both sides.

In Egypt, numerous dental abscesses have been found in Theban skulls from various periods. At Tourah,¹ on the northern borders of Lower Egypt, single or multiple abscesses, due either to exposure of the pulp cavity through attrition or to alveolar inflammation, were met with, both in predynastic and dynastic skeletons.

A very remarkable case of possible infection through such an abscess has been put on record. An old woman from the III dynasty cemetery at Tourah, had upper teeth worn down to stumps, and on each side a huge hole near the site of the first molar, communicating with the antrum. All the molars and most of the other teeth were gone and their alveoli absorbed, leaving behind traces of the former presence of alveolar abscesses. The lower teeth were much worn, and an alveolar abscess had formed at the root of the left first molar. The right first molar communicated with a huge hole on the right side of the mandible, and a necrotic process attacking this bone had eaten away almost the whole of the right half of the lower jaw, the disease extending along the bone and across the symphysis nearly to the left canine tooth. The hole in the mandible was oval, 6 cm. in length, commenced at the junction of the right ramus with the body, and the bare roots of the teeth protruded through the roof of the immense abscess cavity. In the pelvis, an apparently similar necrosis had destroyed practically the whole of the iliac portion of the left innominate bone, spreading to the sacrum and destroying its left auricular surface and much of the bone below it. The acetabulum was intact, but the disease had spread into the iliac segment of the cavity. The only part of the ilium left was the anterior three-fourths of the crest, the anterior superior spina, and a small arch of bone behind the spine. On the right side the ilium was intact, but here the disease had destroyed the ischial tuberosity completely, and had travelled some way up the ascending ramus.²

A very interesting case came from Heliopolis.³ In this skull, one of a typical Egyptian adult, there had been a severe abscess, probably due

¹ Derry, *l.c.*

² The writer has not seen the specimen and can therefore not give a definite opinion, but the diagnosis of cancer of the jaw with metastases in the pelvis does not appear to him improbable.

³ Petrie and Mackey (F.)—Heliopolis, Kafr, Amar and Sharufa, 47.

to the exposure of the pulp cavity of the left upper central incisor. All the incisors were very much worn and the roots of both left incisors opened into the abscess cavity which had perforated on to the face, the palate and into the floor of the nose on both sides of the septum. The left second molar was carious also, and its crown had gone. In the mandible there were primary carious spots on the second bicuspid and first molar.

Many people from Merowe and Faras had abscesses secondary to caries or periodontitis. The second mandibular premolar of one skull for instance, was deeply carious on its lingual side, and the first molar, which had been lost during life, had perhaps been carious also, for the rough, spongy state of the alveolus bore witness to considerable inflammation in its neighborhood. An abscess had formed round one of these teeth, probably round the first molar, and the pus had worked its way firstly from one alveolus to the other, through a sinus large enough to admit a large probe, and secondly into the mouth on the labial side of the second premolar.

In the times of Cleopatra, the Egyptian inhabitants of Alexandria often suffered from dental abscesses, due to various causes. Sometimes, the abscesses were doubtless due to the entrance of microorganisms through an open dental canal, but very often this was not the probable cause. An abscess round the fang of the left mandibular Pm 2 of one case, for example, had evidently not been the result of attrition as the dental canal was entirely closed; nevertheless the pus had ultimately worked its way into the buccal cavity by a fistulous opening 5 mm. wide.

The aetiology of these abscesses was often somewhat obscure, as in the case of an old Christian woman¹ with numerous maxillary alveolar abscesses, whose right maxillary third molar was retained and ankylosed to the bone, the right temporomandibular joint being at the same time "disorganized" by arthritis. The abscess in this case may possibly have been the result of inflammation produced by the retained third molar. If the infection had spread from the exposed pulp to the apex of the root through the apical canal, signs of softening of the pulp chamber should have been evident, whereas in many cases no trace of such previous softening existed. On the contrary, except in teeth obviously carious, the pulp, though freely exposed, appeared hard and healthy, this state of things giving no support to the theory that the microorganisms had penetrated through the apical canal.

¹ A. S. N., 92.

The pathological processes involved in the production of abscesses in some skulls were sometimes very complex, as when dental abscesses coëxisted with attrition and chronic suppurative periodontitis. In such cases, it was impossible to say whether the infective agents had entered through the apical canal, or through the space opened up by suppuration between the tooth and the alveolar wall. In an Alexandrian skull, the tips of the anterior fangs of the left mandibular second molar dipped into two small abscesses, each about the size of a very small pea; the crown was somewhat worn and the dental canal firmly closed. The alveolar wall on the buccal side had been almost completely absorbed and a depression round the roots of the left third molar suggested that these also had been bathed in pus. In this case rarefying suppurative periostitis had evidently opened the way for the infective agent.

The pathological processes which resulted in the formation of another mandibular dental abscess, were still more complex. In this case, both left premolars and the first molar had been lost during life and the left second molar was carious. An oval opening with smooth borders, measuring 12 x 8 mm., occupied on the alveolar border the position of the roots of the absent premolars. An aperture artificially made by me through the external wall of the mandible led to a smooth walled cavity measuring 3.5 x 2.0 cm., in which the roots of the second incisor, first molar and the anterior fang of the second molar protruded. During life, therefore, all these roots and those of the absent premolars had been bathed in pus, and the premolars and first molars had evidently either fallen out or been removed some time before death, a wide fistula remaining behind. The alveolar walls of the second and third molars had been partly absorbed and the teeth were thickly encrusted with tartar.

An old person with teeth somewhat worn, had carious right molars. The right, first and second premolars had been lost just before, or had dropped out after death, though not before their alveoli had been converted by long continued suppuration into a cavity measuring 17 x 12 mm., and the buccal alveolar wall had been absorbed, with the exception of the posterior third which was perforated by a small opening on the buccal side. Almost the entire roots of the carious first molar and to a less extent those of the neighboring molars, were exposed, and all these teeth were covered with thick tartar. The path followed by the infective agents therefore, whether through a carious tooth or a suppurating alveolar border, was not at all certain. The ætiology of

many of these suppurations, especially in the maxillae of young people, remained obscure, for no obvious disease was found either in the tooth itself or its neighborhood.

Non-infectious periodontitis due to mechanical causes such as blows, etc., was rare in ancient Egypt, for no cases are on record; nor were there any reasons to suppose that intoxication by arsenic, mercury or phosphorus played any part in the causation of dental disease. The majority of alveolar and perialveolar abscesses was evidently, if not due to, at any rate associated with chronic suppurative periodontitis.

The name of *pyorrhoea marginalis* is given to a group of well defined clinical symptoms, and anatomically it has all the characteristics of chronic, suppurating, marginal periodontitis. The disease is now considered by many to be caused by an amoeba, the presence of which in Egypt has lately been demonstrated by Dr. Crendiropoulo, my assistant.¹ In modern Alexandria it attacks the English, French, Italians, Greeks, Egyptians, Jews, Berberine and Negroes, people of the most different habits, diatheses, ages and conditions, with truly international impartiality. The author has seen it in two members of the same household; the first, an Egyptian cook whose tartar-covered teeth had never been brushed; the second a fair Englishwoman, with spotless dentition, who had never had an illness except infantile measles.

The differences between the periodontitis caused by caries and other local lesions, and the periodontitis of *pyorrhoea marginalis*, are mainly clinical; the first being limited to a few teeth and coming to an end when the diseased teeth or lesion are removed, the other being a chronic disease, usually spreading from tooth to tooth which remain healthy. Suppurating chronic periodontitis occurred in ancient times both in Europe and Africa. In Europe the fossil man of La Chapelle aux Saints² is said to have suffered from pyorrhoea. He lived in the Mousterian period, and was therefore certainly a hunter, though possibly also an agriculturist.

According to Baudouin, who described fully the pathological alterations of this skull, the alveolus of the left upper canine is diminished in depth and its cavity has a spongy appearance, doubtless owing to the long-standing inflammation which led to the loss of this tooth. The alveolus of the left first upper premolar also is shallower than normal.

¹ While the amoebæ are constantly found in this disease they are not considered by most authorities to be in any way concerned with the causation. (J. H. M.)

² Baudouin (Marcel)—La Polyarthrite alvéolaire depuis la quaternaire jusqu'à l'époque romaine. *Gaz. Méd.*, Paris, 1913, 397.

The alveoli of the right lower incisors, canine and first premolar, form large irregular cavities due to the partial absorption of their walls. The alveolus of the second molar is in a better state of preservation and slopes forwards. All the molars were lost long before death and the alveoli, having been absorbed, are depressed and concave. The alveoli of the left incisors and canine are well preserved, the pathological signs are but slight and their diminished depth alone attracts attention. The alveolar border behind the second molar having been absorbed, the mandible is atrophied correspondingly. The third molar, on the other hand, was lost probably only just before death.

It is very probable that the loss of his molars in the La Chapelle man was the result of *pyorrhæa alveolaris*, though it may also have been caused by caries. With regard to the other alveolar lesions in this skull which have been described as being due to *pyorrhæa*, their causation, in my opinion,¹ is by no means clear.

The diagnosis of *pyorrhæa alveolaris* was made in the case of a neolithic skull also,² in which all the left mandibular molars, the second maxillary premolars and all the molars had been lost through disease during life; but here again caries may have been the active agent. Such cases of almost total destruction of teeth by caries occur now-a-days in Egypt. I have, for instance, observed for 18 years a man, who, during that period has lost from caries all the upper teeth with the exception of the second left molar, and all the lower teeth with the exception of the incisors, canines and the third molars, and who yet had never a sign of *pyorrhæa*. It is possible therefore that both the above subjects had lost their teeth through caries. The writer has observed similar lesions in a considerable number of ancient skulls.³

The typical lesions of chronic *periodontitis marginalis* were conspicuous in several skulls from Merowe, the fangs of many of the teeth being bare and looking as if they had been pushed out of their sockets. This early stage was the result of the absorption of the alveoli and consequent exposure of the roots. In a more advanced stage, the alveolar walls had completely disappeared, and consequently the fangs were exposed for a considerable length, while in a still more advanced condition, the alveoli were almost completely absorbed and the teeth,

¹ My opinion is based on an excellent cast of this skull only, and is therefore provisional.

² Baudouin (Marcel), *l.c.*

³ It is rather strange that the report on the *A. S. N.* does not mention the presence of this disease in Nubia, though there are plain indications that it was not uncommon there.

on the point of being shed, remained attached to the skull by the tips of the roots only. It was most probably also this disease which was responsible for some edentulous ancient Sudanese skulls with alveolar borders completely destroyed.

Skulls from Faras in Nubia, dating from the time of the Meroitic kingdom, showed the same typical lesions. This is specially interesting because the disease exists now at Faras as it did 2,000 years ago, and, when I was collecting ancient pathological specimens there, I was consulted by many members of the present population who had lost most of their teeth from pyorrhœa and were fast shedding the remaining few. The disease is spread all over Egypt and exists even in remote localities, far away from all civilization. In the desert of Sinai, on the gulf of Akaba, I found seven men, the whole garrison of a small isolated fort, who had the typical symptoms of *pyorrhœa alveolaris*, and were in a wretched state of health in consequence.

The most striking pathological lesions in ancient Coptic skulls were perhaps suppurative periodontitis. In one case for instance, suppuration had completely exposed two molar teeth, and the pathological process had extended along the alveolar borders of the maxillæ and mandible, leaving the teeth bare and most of them very loose. Such lesions were extremely common at that period of Egyptian history.

Interesting as were the Coptic cases, and those from Merowe and Faras, chronic suppurative periodontitis of the ancient Egyptians was best studied on Egyptian predynastic skulls, in which the lesions were most typical. In these, the first lesions were usually situated on the buccal side of the anterior or posterior root of the first molar, the alveolar wall being partly absorbed and the root thus laid bare for some distance. The remaining alveolar border was often riddled with small holes with smooth walls and borders, evidently the effect of unequal destruction of bone by a chronic inflammatory suppurative process. A more advanced stage was reached when this process had extended between the roots of the first molar and into the spaces between this tooth and its neighbors on one or both sides, and had thus given rise to a honey combed surface. Owing to the continued absorption of the alveolar wall, the whole root was laid bare, even when as sometimes happened the lesions remained limited to the root. Absorption was nearly always most marked on the buccal side of the first molar or of any other tooth that was attacked.

The suppuration causing the disappearance of the alveolar wall and the loosening of the tooth appeared to follow one of two courses, which,

though sometimes combined were nevertheless fairly distinct. In the first, most often observed in the molar region, the absorption of the alveolar wall, starting on the free border gradually extended towards the apex of the alveolus, and the whole or nearly the whole alveolar wall was absorbed, often without the formation of an abscess. In the other, the disease extended to the bottom of the alveolus without marked changes being noticeable in the upper part of the alveolar wall, but the bone protecting the tip of the root was absorbed, and the pus found its way into the mouth through this perforation near the extremity of the alveolus. Repeated examination gave the impression that the first process is typical of an acute form of disease, for the inflammatory lesions in the neighborhood were severe. The second indicated a more chronic form, in which the infective material having penetrated between the tooth and the alveolus had produced a small purulent collection round the apex of the root. The surface of the maxilla or mandible behind the tip of the fang was excavated somewhat but not pitted, and exhibited no obvious signs of inflammation, its smooth surface somewhat resembling a stone worn down by the prolonged action of water. The apex of the fang never adhered to the neighboring bone, and the tooth is usually tightly held by what remains of the alveolus. The irregular pitting caused by the inflammatory process often extended bilaterally along the alveolar borders of several or all the maxillary or mandibular teeth, or of both. As a rule however, the pathological process had attacked two or three teeth only and had extended to the others later on, for when several alveoli had been absorbed during life in a skull with lesions of suppurative periodontitis, the disease clearly had existed long before death, and after causing the loss of several teeth it had spread to the alveoli found diseased at the time of death.

The teeth, even when the walls of their alveoli had been almost completely destroyed, were healthy as a rule, except for the usual deep attrition of ancient Egyptian teeth, and very often though not always, for more or less thick deposits of tartar. Sometimes, however, the root was shortened owing to absorption of its tip which was then smooth and rounded—blunted, so to speak. Very rarely the roots, although smooth, were somewhat uneven as if a slow process of ulceration had been acting. The crown itself was normal except for the changes due to attrition. In a late stage the alveolar septa were absorbed and the teeth might then lie in a cavity, which during life was doubtless purulent. As the septa between two or more neigh-

boring teeth also disappeared, the alveoli of several teeth ran together, especially in the molar regions, and a huge cavity was thus formed by the coalescence of several alveoli.

The ultimate result of the process in the Egyptian skulls was often loss of the teeth, but sometimes before this occurred some, especially the premolars and molars, were forced out of position, owing to their attachment having been loosened by the absorption of the alveolus and the accompanying suppuration. The teeth had easily yielded to the presence of masticating or other movements, and had been ultimately pushed into a position at an angle with the other teeth. The tips of the roots of the "dislocated" teeth were thus directed towards the buccal side, and the roots were often bare for most or all of their lengths even. Such teeth were not infrequently firmly fixed in their new position, so firmly indeed that their removal from the skull was not at all easy, and sometimes the life of the bearer had been prolonged long enough for a new masticating surface to have formed on the lateral aspect of the fang lying almost at right angles to the other teeth.

This process then was essentially chronic, spreading from tooth to tooth and often ending in the loss of one, several or even all the teeth. Very probably, the edentulous maxillæ and mandibles discovered in many ancient graveyards had been rendered so by this disease, but on the other hand there can be no doubt that in the large majority of cases the disease improved locally or generally before the death of the patient. More than 60 per cent of predynastic, dynastic, Roman, and Coptic Egyptians had one or several teeth with exposed fangs, sometimes for as much as two-thirds of their length, and yet the alveolar borders, somewhat thickened, were smooth and even and the teeth themselves were healthy and *firmly fixed in their sockets*. This condition was a sign that the disease had become dormant after producing more or less severe lesions. In many cases there was no reason to doubt that the disease had been cured with the loss of one or several teeth.

The ætiology of this condition in ancient Egyptians is by no means clear. The examination of the predynastic and dynastic Egyptian skulls from Naga-ed-Deir, for instance, might lead to the conclusion that tartar had played a considerable rôle. Deposits of tartar on Egyptian teeth were common at all periods from predynastic to Coptic times, being laid down in layers round the tooth, and being always thickest at the margin of the gum. The teeth of other ancients

besides Egyptians, were sometimes thickly covered with it. Herodotus¹ relates that, after the battle of Platea, there was found a skull in which "the upper jaw had teeth growing in a piece, all in one bone, both the front teeth and the grinders." The son of Prusias, king of Bithynia, and the king of Pyrrhus, are said to have been thus affected. Similar cases have been described in modern times, where several or all the teeth even were imbedded in solid tartar.

Its presence is said to predispose to pyorrhœa and to hasten its progress by penetrating between the gum and the tooth, or between the alveolus and the tooth and thus loosening the latter. It is impossible to decide from the examination of a skull's teeth whether the tartar was deposited before or after the inception of pyorrhœa, but what the examination does show is that, very often, the deposit is confined to the necks of the teeth. It would appear therefore that tartar did not in those days play the important part which it is said to play now, and that in many cases its deposit on the root was of little if any pathogenic importance. The tartar was in many cases rather soft, white, and was fairly easily detached with the sharp end of a knife. This kind was most often seen in Roman, Coptic and Greek skulls, whereas the brown variety was more common in predynastic Egyptian skulls. The enamel underneath was perfect.

Severe chronic suppurative periodontitis is so often associated with marked attrition of the teeth that the question arises whether the periodontal disease may not be caused, or at any rate rendered worse, by the latter. The answer to this question without clinical observations is well nigh impossible. When the periodontitis and the subsequent suppuration and perforation into the mouth were most marked at the apex of the root it is fair to assume that the infecting micro-organism entered by the dental canal, even if as was usually the case, the pulp was unaltered. On the other hand, when the lesions were most marked at the alveolar borders, the probability was great that attrition had played no part. In many cases probably, the micro-organisms causing chronic suppurative periodontitis were carried mechanically from the alveolar margin to the crown of the tooth and thus reached the bottom of the alveolus through an open dental canal.

VI. CORRELATION OF PATHOLOGICAL PROCESSES

Reading through the Field Notes of the *Archaeological Survey of Nubia*, the frequent coincidence of dental disease and of *spondylitis*

¹ IX, 83.

deformans, or of other chronic articular lesions, immediately attracts notice. These notes, it may be added, are all the more valuable because both observers were unprejudiced as to any theory regarding a possible correlation between lesions of the teeth and chronic joint disease.

Without going into the detail cases, a perusal of the records of the Survey makes it plain that *spondylitis deformans* and chronic osteoarthritis co-existed in many cases and at all periods of Nubian history, and that often lesions of both were very severe.

The connection between chronic arthritis and dental disease is not disproved by the fact that, in many cases of joint disease the dentition was stated to be healthy, for two reasons. The first is that in almost all cases of spondylitis the teeth were greatly worn, the pulp cavity was exposed and thus a path for septic absorption was open. The second is that no mention is made of suppurative periodontitis which certainly did exist, as severe and multiple abscesses at the roots of the teeth were often mentioned and attributed to infection spreading down to the roots through the medulary canal opened by attrition. Undoubtedly infection often entered through this open path.

The author's opportunities of studying both diseases clinically have not been many, but the few observations on modern male Europeans and Egyptians in Egypt, do not lead him to think that spondylitis is always caused by dental disease, *e.g.*, *pyorrhœa alveolaris*. The few cases of chronic spondylitis (some of which have lasted for years) of which he obtained a good clinical history, had suffered from severe gonorrhœa, and several had not a trace of pyorrhœa. Moreover, pyorrhœa alveolaris is extremely common in Egypt now, whereas cases of severe chronic spondylitis are certainly not many. It is clear however, that further investigations in these lines are desirable.

VII. SYPHILIS; RICKETS

Neither syphilitic nor rickety teeth were discovered, and this observation confirms the evidence derived from the study of skeletons, for no syphilitic bone dating from ancient times in Egypt has been unearthed so far, and rachitis was very rare indeed if it existed.

Sometimes the teeth were transversely striated, which was perhaps caused by some constitutional disturbance.

No lesions have been found pointing to the immoderate use of the toothbrush, and indeed there is no definite observation proving that ancient Egyptians used this instrument of torture. The teeth found

in Alexandria and some of those from Faras and Merowe were remarkably clean and white as a rule and this may have been due to the use of some cleaning instrument during life; on the other hand, the pre-dynastic, dynastic and Coptic teeth were often covered with a thick layer of tartar.

VIII. DENTISTRY

The writer's studies have not revealed any facts showing that the Egyptians practised operative dentistry, in fact the evidence rather points to the conclusion that even extraction was very seldom performed. It is not rare to find in Egyptian cemeteries diseased teeth almost dropping out of abscess cavities, or carious teeth which have caused extensive disease, and yet the patient was allowed to die without the relief that would have been afforded by a very simple operation. It is difficult to believe that extractions were not practised at times, but the evidence on that point is nil.

No Tooth filled with gold or any other metal has been found. The only set of artificial teeth that has been discovered comes from a Roman grave and is deposited in the Alexandria Museum. Clearly it could have been of but little use in chewing and was probably tied in for æsthetic purposes only.

A similar set of teeth comes¹ from a grave of old Sidon, and two copper coins, an iron ring, a vase of most graceful outline, a scarab and twelve very small statuettes of majolica representing Egyptian divinities, were found in the same grave. It consisted of four lower incisors (not "maxillary" as Gaillardot stated), and two canines held together by strong gold wire. Guerini pointed out that teeth strung together in the same manner are now being used in India.

IX. CONCLUSIONS

1. Among ancient Egyptians, anomalies in position, structure and number of the teeth were rare and did not seem to become more common as modern times were approached.

2. Attrition was, as it is now, very marked, and played probably a considerable part in favoring the entrance of the micro-organisms of suppuration, but not of those producing caries.

3. Dental caries occurred at all periods of Egyptian history. It is impossible to say for certain without more extensive statistics whether caries was much less common in ancient than in modern times, but

¹ In Renan's *Mission de Phénicie*. See also Guerini—*History of Dentistry*, 29.

the data from Tourah undoubtedly point to a very small percentage of caries in the predynastic period. Nothing definite is known regarding the incidence of caries in children.

4. Alveolar and perialveolar abscesses were common at all times in Egypt, and were evidently produced by the same processes as they are now. Attrition played some part in the ætiology of these abscesses, but the majority were secondary to chronic suppurative periodontitis, and a few to caries.

5. Chronic suppurative periodontitis was a common disease in ancient Egypt, and the most frequent cause of the loss of teeth.

6. Spondylitis and osteo-arthritis were in numerous Nubians and Egyptians with diseased dentition, but a definite connection between the two affections has not been established.

7. No syphilitic or rachitic teeth have been found in the Egyptians up to and including the Coptic period.

8. There is no evidence to show that the toothbrush was in common use, and no such instrument has been found in Egyptian tomb-deposits, but the Alexandrians and the people from Merowe and Faras appear to have used some cleaning instrument.

9. The severity of many of the lesions found post-mortem—lesions which were undoubtedly very painful and could have been easily relieved—show that dentists did not interfere operatively in many, if in any cases.

10. A set of false teeth has been found dating from Roman times. This, however, like the one found at Sidon, was perhaps imported from Italy or Greece.

No one realizes more than the writer how incomplete this paper is, especially as regards statistics concerning the incidence of dental disease at various periods of Egyptian history, and the reason for this important lacuna is that the material which has been examined is unsuitable for statistical study. Satisfactory statistics of dental disease will be obtained only when large cemeteries containing bodies of several periods are excavated with due regard to pathological study; but up to the present, except in a very few cases, archæologists have been more concerned about the objects found around skeletons than about the skeletons themselves.

EXPLANATION OF PLATES

PLATE I

FIG. 1. Predynastic, Naga ed Deir. Abnormalities of roots of molars.

FIG. 2. Predynastic. Attrition of molars and premolars, crowding of incisors.

FIG. 3. Ancient Nubian. Young adult. Accessory dental unit situated to lingual side of interval between right posterior premolar and first molar.

FIG. 4. Predynastic. Great and oblique attrition of incisors and canine. Roots of premolars fused, labial wall of alveolus has disappeared, partly owing to post-mortem injury; there is however, evidence of suppuration on the distal side of the posterior premolar. The molars disappeared long before death.

FIG. 5. XIth dynasty (from Murray's "The Tomb of Two Brothers"). Well marked attrition; a supernumerary incisor; a bifid incisor.

FIG. 6. Nubia. Supernumerary tooth at *a*. (A.S.N.)

PLATE II

FIG. 1. From Ras el Tin (Roman period). Alveolus of a tooth which was irregularly placed. Most teeth lost after death. Right canine and anterior premolar broken probably after death. Molar regions show signs of severe dental and perialveolar disease.

FIG. 2. Predynastic, Naga ed Deir. Alveoli of 2nd molar and posterior premolar absorbed. Crowns of canine and anterior premolar show great attrition, especially on buccal side, whereas in the first molar the centre of the crown is the part worn down most deeply. Canine covered with tartar at the neck. Some absorption of the alveoli of all the teeth, most marked round the root of first premolar which is bare for its whole length, and the wall opposite the tip of the root is smooth and rounded. Alveoli round roots of 1st molar also partly absorbed; that of second premolar almost completely absorbed, doubtless owing to long previous suppuration. Malposition of 3rd molar.

FIG. 3. Cleopatra period. Faulty implantation of third molar. Alveolus of second molar completely absorbed.

FIG. 4. Pyramid period (?) Some malposition of third lower molar; corresponding maxillary tooth is much smaller than its neighbor. Mandibular molars somewhat bare, alveolar borders showing signs of inflammation; second lower premolar bare and with distinct pitting of alveolar border. Roots of third upper molar bare, absorption of alveolar walls of first and second molars due to pathological process which, judging from the smoothness of the borders, was healing at the time of death.

FIG. 5. From Ras el Tin, Roman period. Second left molar shows small oblong enamel nodule. Some absorption of alveolar wall of same tooth.

FIG. 6. A Gizeh pyramid builder. Third lower molar abnormally situated, corresponding upper tooth much smaller than its neighbor. Second molar lost during life, alveolus almost completely absorbed. Part of anterior root of first molar bare, but process of absorption appears to have stopped before death. Roots of anterior premolar and canine bare for about two thirds of their lengths. Alveolar border of the three upper molars partly absorbed leaving considerable part of roots completely bare. Borders of premolars and canine show marked signs of perialveolar inflammation.

PLATE III

FIG. 1. From a pan grave at Ballalish. Early attrition of teeth. Third molar almost normal; second worn flat without formation of cavities; in first molar attrition more advanced, a cavity has formed on the proximal lingual and another smaller on distal lingual side. In first right molar similar cavities have coalesced. Remaining teeth show slight attrition, most marked in the first premolars in which three small cavities are forming.

FIG. 2. From a pan grave at Ballalish. Early stage of attrition of all teeth. Incisors show narrow central groove in the biting edge. Attrition of first molar characteristic; right tooth worn into four distinct cavities, of which the two on the buccal side are coalescing. On left the two buccal and the distal cavities have united into one, the fourth being still separate. Second molars are slightly worn with formation of cavities near proximal surface. Third molar practically normal.

FIG. 3. From a pan grave at Ballalish. Early attrition in a young adult, most marked near lingual border of first molar. Cavities in first and third molars.

FIG. 4. Predynastic, Naga ed Deir. Advanced, somewhat irregular attrition.

FIG. 5. Cleopatra period. Second molar lost before death, roots of all remaining teeth partly bare. Posterior premolar reduced to a carious stump at apex of which there is an abscess cavity, which communicates with alveolar cavity of proximal root of first molar.

FIG. 6. Gizeh pyramid. Crown of first molar completely destroyed by caries, leaving two carious stumps. Tip of the posterior root almost completely absorbed. Alveolar wall had disappeared during life, bone underneath partly eaten away. Anterior root of the same tooth is almost completely bare. Roots of second and anterior root of third molar also bare but some of the injury to alveolar wall probably post mortem. Perialveolar lesions of other teeth are slight, but all along alveolar border and for some distance below, signs of chronic inflammation.

PLATE IV

FIG. 1. Cleopatra period. Maxilla of an elderly person. Crowns of remaining teeth show great attrition, especially left premolars and first left molar. Beginning caries of this tooth on its approximal border. Caries of left second molar posteriorly. First right premolar broken after death. All right molars lost during life. Hole seen at *x* made after death.

FIG. 2. Predynastic, Naga ed Deir. Lesions of chronic suppurating periodontitis along whole length of alveolar border. Roots of incisors and canine bare for some distance, and alveolar border over lateral incisor pitted. First premolar's root bare and tip of alveolar wall absorbed, only a narrow bridge of bone being left. The tooth is much worn. Second premolar shows similar changes, and bone about tip of the root and all round deeply pitted as result of suppuration. Almost whole of alveolar wall of first molar absorbed, and remainder carried by chronic periodontitis. Alveolar margin round two remaining molars somewhat pitted. All teeth show yellow tartar.

FIG. 3. Coptic. Advanced oblique attrition; signs of alveolar suppuration.

FIG. 4. Predynastic, Naga ed Deir. Advanced attrition; incisors and canines deeply worn on lingual side. Dental canal of all premolars opened. Marked signs of chronic suppuration round the side of first right molar which has been shed during life and the alveolus of which is partly obliterated, and round second premolar on same side the buccal wall of whose alveolus has been absorbed and the tooth has

been "dislocated," so that its root lies almost at a right angle to those of other teeth. The tooth had become firmly fixed in that position for a small flat surface, evidently the result of mastication had formed on the side of the root. Lesions of chronic periodontitis exist all along the alveolar borders of both remaining right molars, canines and incisors. Left second premolar with first and second molars were shed during life as a result of process resembling that noticeable on the right side.

FIG. 5. XII-XVI dynasty. Interior root of first molar contained in a smooth-walled cavity result of previous inflammation and suppuration (suppurative periodontitis), tip of root surrounded by layer of new bone. Superficial periostitis below first molar.

PLATE V

FIG. 1. Coptic skull. Advanced caries of first right molar. A sinus had formed and pus had perforated through palate. The sinus leading from tooth to palate was still plain.

FIG. 2. Macedonian period, Chatby. Attrition of teeth which are planted somewhat irregularly. Large accumulation of tartar at junction of root of first right molar with the crown; tooth dislocated towards the labial side owing to intense suppurative periodontitis; small perforation in the crown of the tooth accidental.

FIG. 3. Predynastic, Naga ed Deir. Advanced and irregular attrition. An abscess about posterior root of first right molar.

FIG. 4. Coptic period. Alveolus of left anterior premolar completely absorbed, a thin bridge of bone superiorly being all that remains of it; pus had evidently burrowed into the neighboring parts of the mandible; alveolus itself of normal size. In neighboring teeth same process has been going on for the roots are partly bare, and at apex of root of posterior premolar a sinus has been formed. Other side was equally badly afflicted and upper jaw of same skull is almost edentulous, and had been so for some time before death, for the alveoli had been so completely absorbed that not a trace is left. The suppurating process therefore had attacked the whole mouth and had lasted for years before the patient finally succumbed.

FIG. 5. Roman period, Kom el Shougafa. Roots almost completely bare.

PLATE VI

FIG. 1. Coptic skull. All roots exposed. Lower third molar lost during life, its alveolus completely absorbed. Second molar has deep carious cavity on buccal side of root. Alveoli of second and first molar completely absorbed on the buccal side, probably owing to long continued suppuration. Roots of the other teeth also bare.

FIG. 2. Predynastic, Naga ed Deir. Third molar fell out during life, and there are signs of perialveolar inflammation at *a*. Roots of second molar completely bare, lying in open cavities which doubtless were filled with pus during life. Signs of chronic periodontitis all along the alveolar border.

FIG. 3. A pan grave, Ballalish. Deep-seated abscess connected with alveolus of lateral incisor, perforating through the palate into mouth.

FIG. 4. Cleopatra's period, Ras el Tin. First molar wholly bare, owing to chronic rarefying periostitis. Roots of premolars partly bare; second and third molars nearly normal.

FIG. 5. Cleopatra period, Ras el Tin. Both left premolars and first molar lost during life and left lateral incisor carious. An oval opening with smooth borders, 12 x 8 mm. in outer wall of the jaw in alveolar border, in premolar region. An

aperture artificially made through the external wall of the mandible leads into a smooth-walled cavity 36 x 2 cm., in which roots of canine, lateral incisor and anterior root of second molar are exposed. During life, therefore, these roots lay in extensive abscess cavity which, after the premolars and first molars have been lost, communicated by a wide opening with the mouth.

FIG. 6. Predynastic, Naga ed Deir. Molars and premolars with advanced lesions of periodontitis, most marked round first and second molars. Many little pits due to the inflammatory process seen along whole length of alveolar border.

PLATE VII

FIG. 1. Predynastic, Naga ed Deir. Incisors lost, crowns of canine and first molar broken, probably post-mortem. Crowns of premolars and first molar markedly and obliquely worn. Root of second molar bare for considerable length and near its tip there is a deep cavity which connects with alveoli of second and first molars.

FIG. 2. Predynastic, Naga ed Deir. The third molar was evidently very small. Root of second molar somewhat exposed and crown distinctly worn. One root of first molar bare for almost its whole length. Distinct pitting round the roots of the premolars which are bare.

FIG. 3. Predynastic, Naga ed Deir. Crown of first molar deeply worn, root surrounded by open space which during life was doubtless filled with pus. Signs of inflammation all round this root and for some distance along the palate. Second molar's root partly bare, crown worn. Third molar was probably small.

FIG. 4. Predynastic. Abscess cavity at base of first premolar which was shed before death. Crown of second premolar broken post-mortem, its alveolar wall completely absorbed and alveolus evidently communicated with abscess cavity of first premolar. The upper part of abscess wall especially near alveolar border shows signs of active pathological process, whereas lower part of wall is smooth, rounded as if pathological process had been quiescent there. Tip of root of second premolar is rounded off as if part had been absorbed.

FIG. 5. Cleopatra period, Ras el Tin. Right incisor and canine lost after death, second and third molars during life. Whole left molar and premolar region is changed into a huge cavity with spongy wall, owing to absorption of alveolar and inter-alveolar septa.

FIG. 6. Meroitic Kingdom, Faras. Middle-aged person. Completely edentulous upper jaw.

FIG. 7. Predynastic, Naga ed Deir. Advanced suppurative periodontitis. All the teeth were shed during life and the alveoli with their borders show signs of inflammation and suppuration.

PLATE VIII

FIG. 1. Coptic period. Transverse striation of teeth.

FIG. 2. Coptic period, old woman. Completely edentulous upper jaw. Alveolar process has entirely disappeared.

FIG. 3. Predynastic, Naga ed Deir. Most teeth lost during life, possibly owing to chronic periodontitis. Enlarged blood-vessel canals all over the palate.

FIG. 4. Predynastic, Naga ed Deir. Edentulous maxilla with alveolar borders almost completely absorbed. Foramina of blood-vessels on palate enlarged.

FIG. 5. Meroitic Kingdom. Middle-aged man. Completely edentulous mandible and almost completely edentulous upper jaw.

FIG. 6. Meroitic Kingdom. Edentulous skull.

PLATE I.

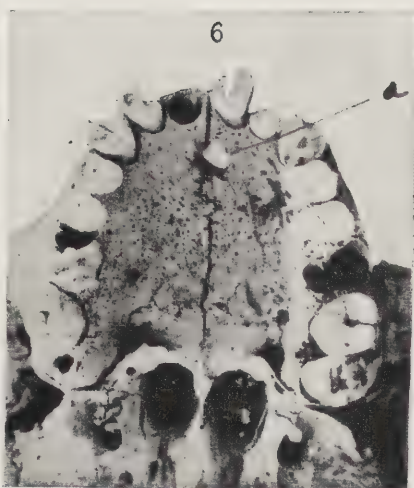
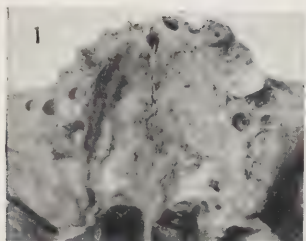




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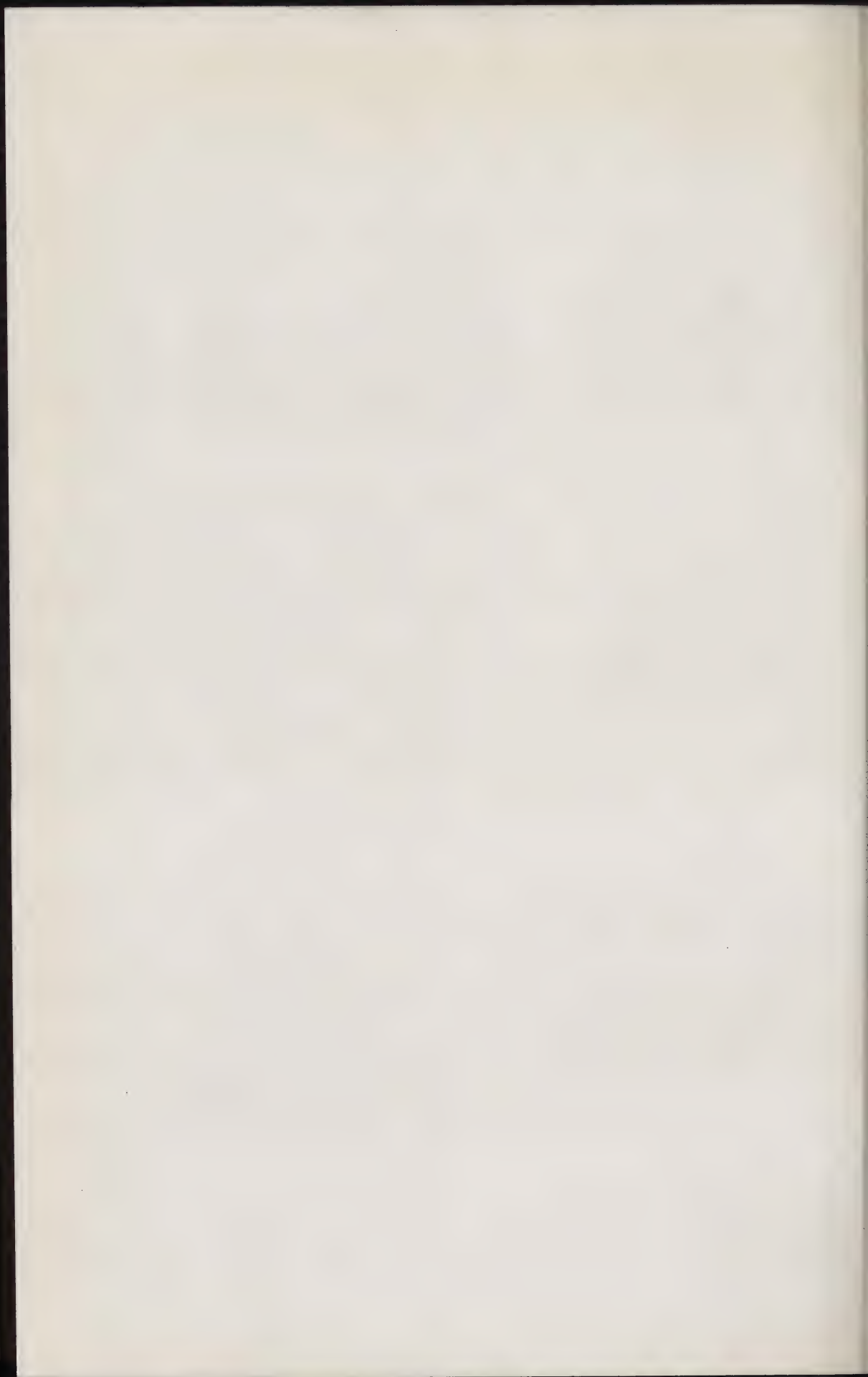


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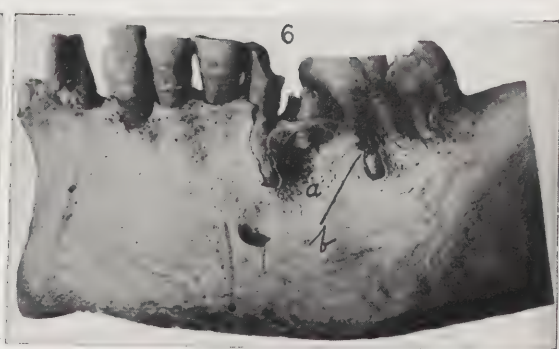
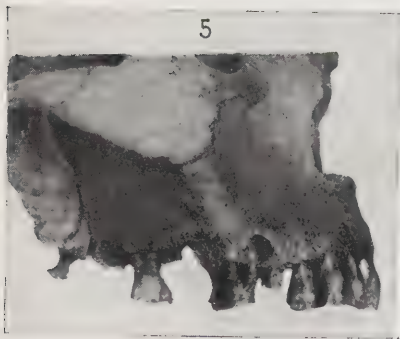
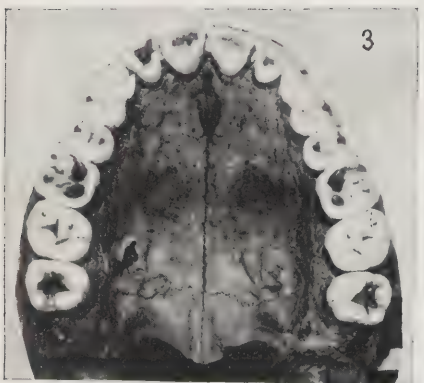
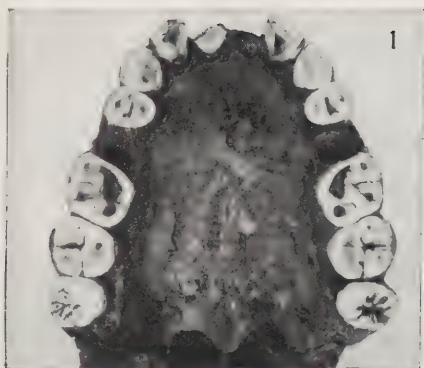
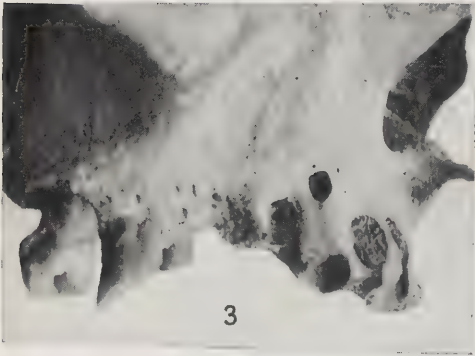


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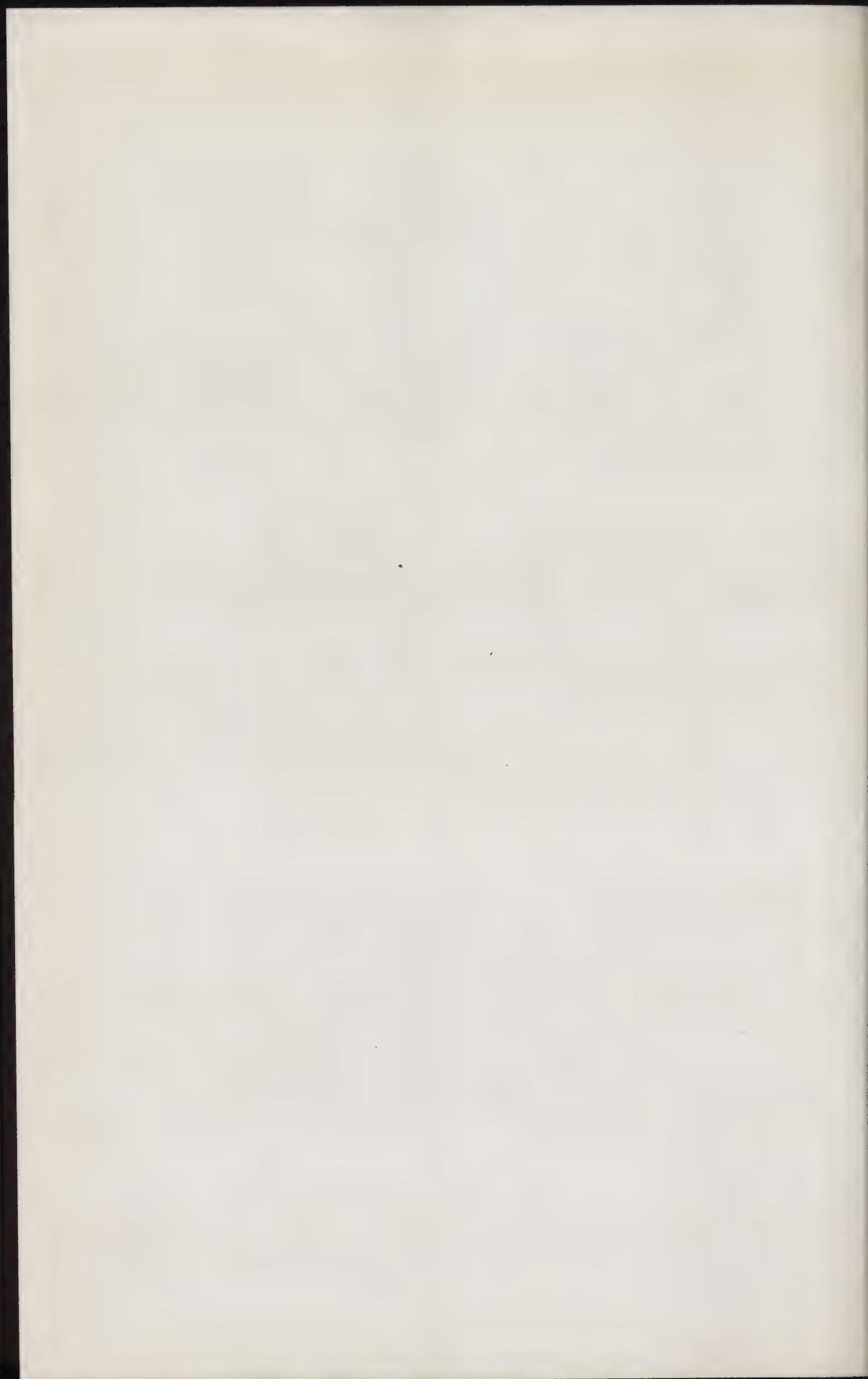
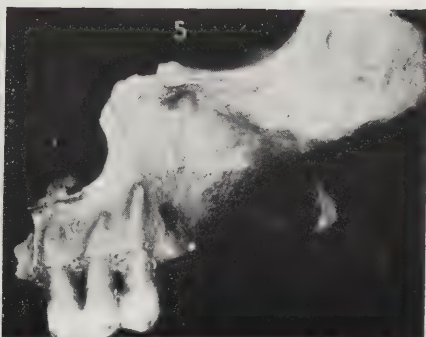
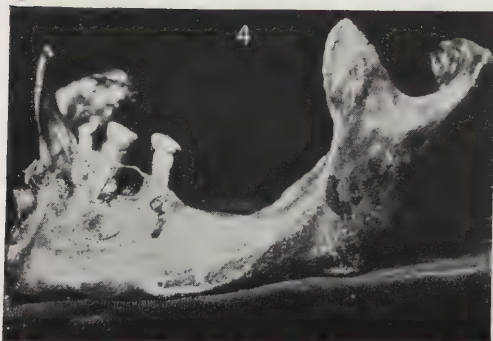
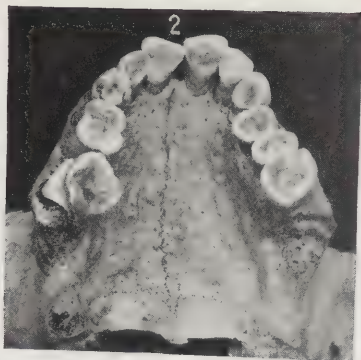


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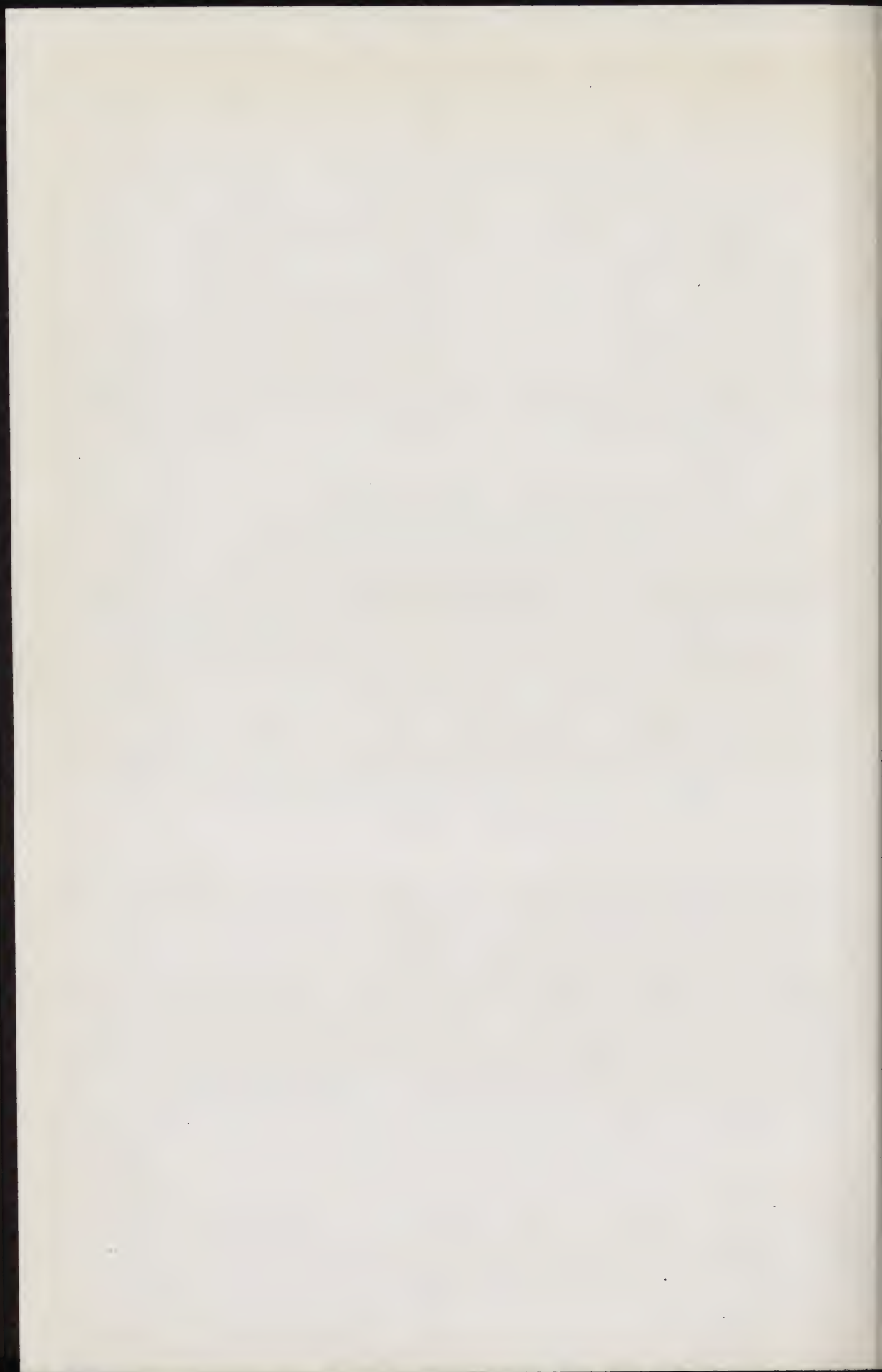
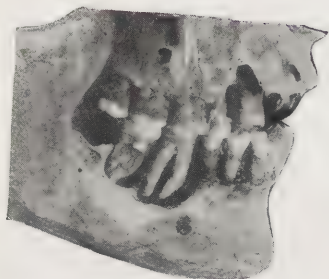
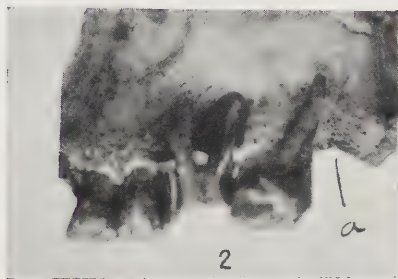


PLATE VI.



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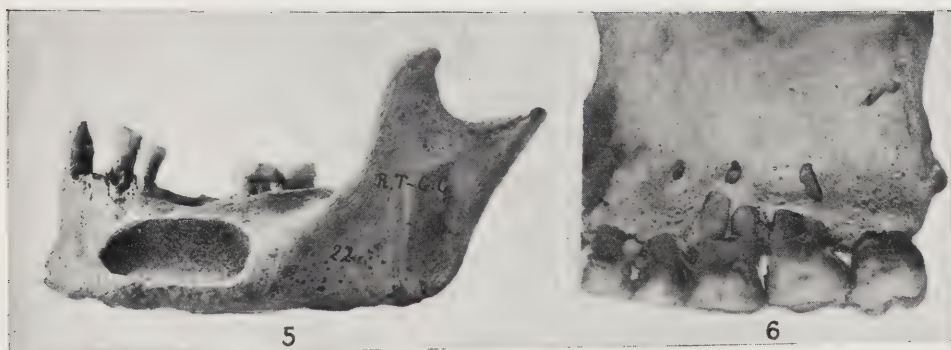
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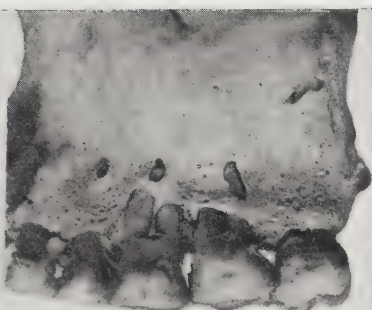
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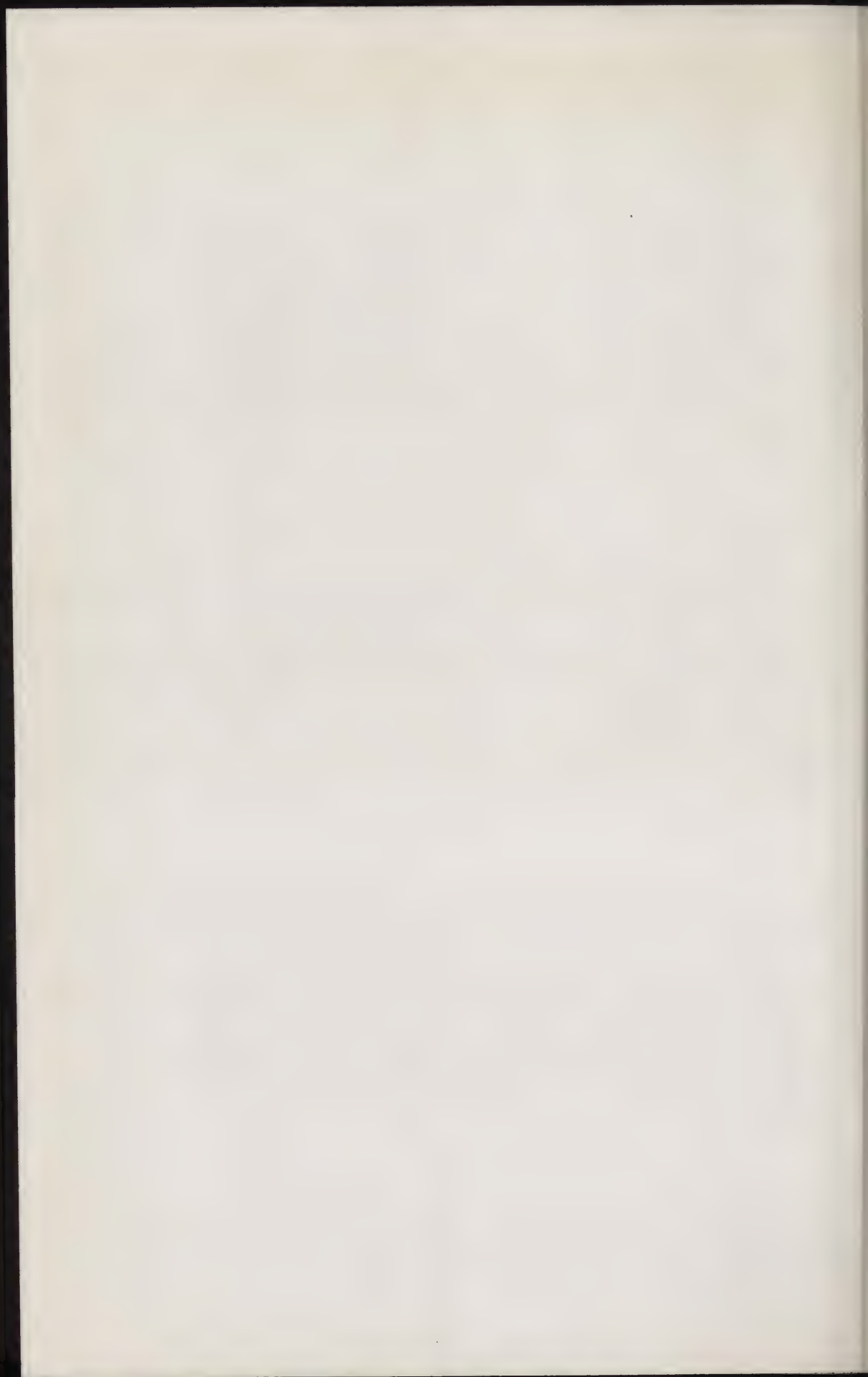
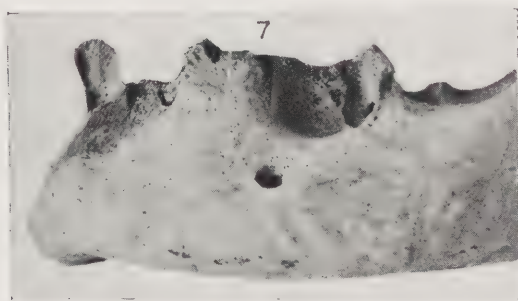
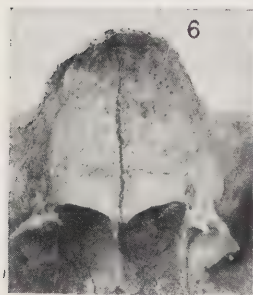
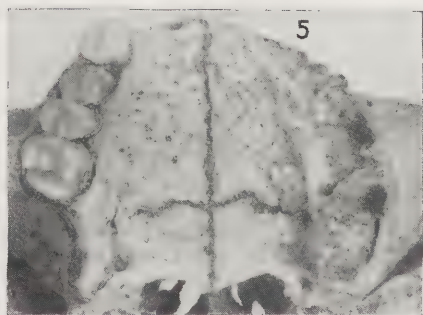
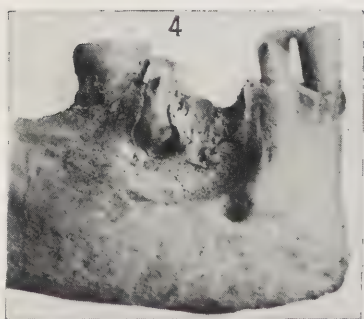
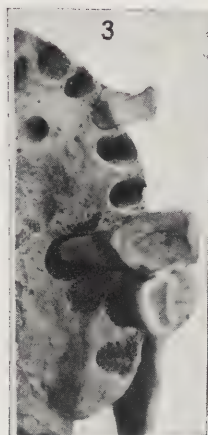
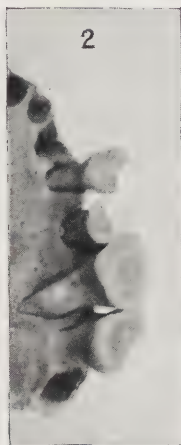
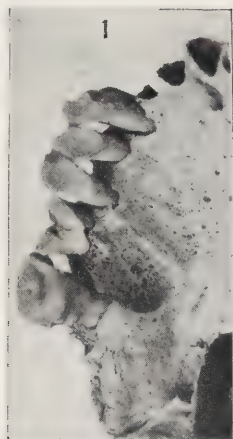


PLATE VII.



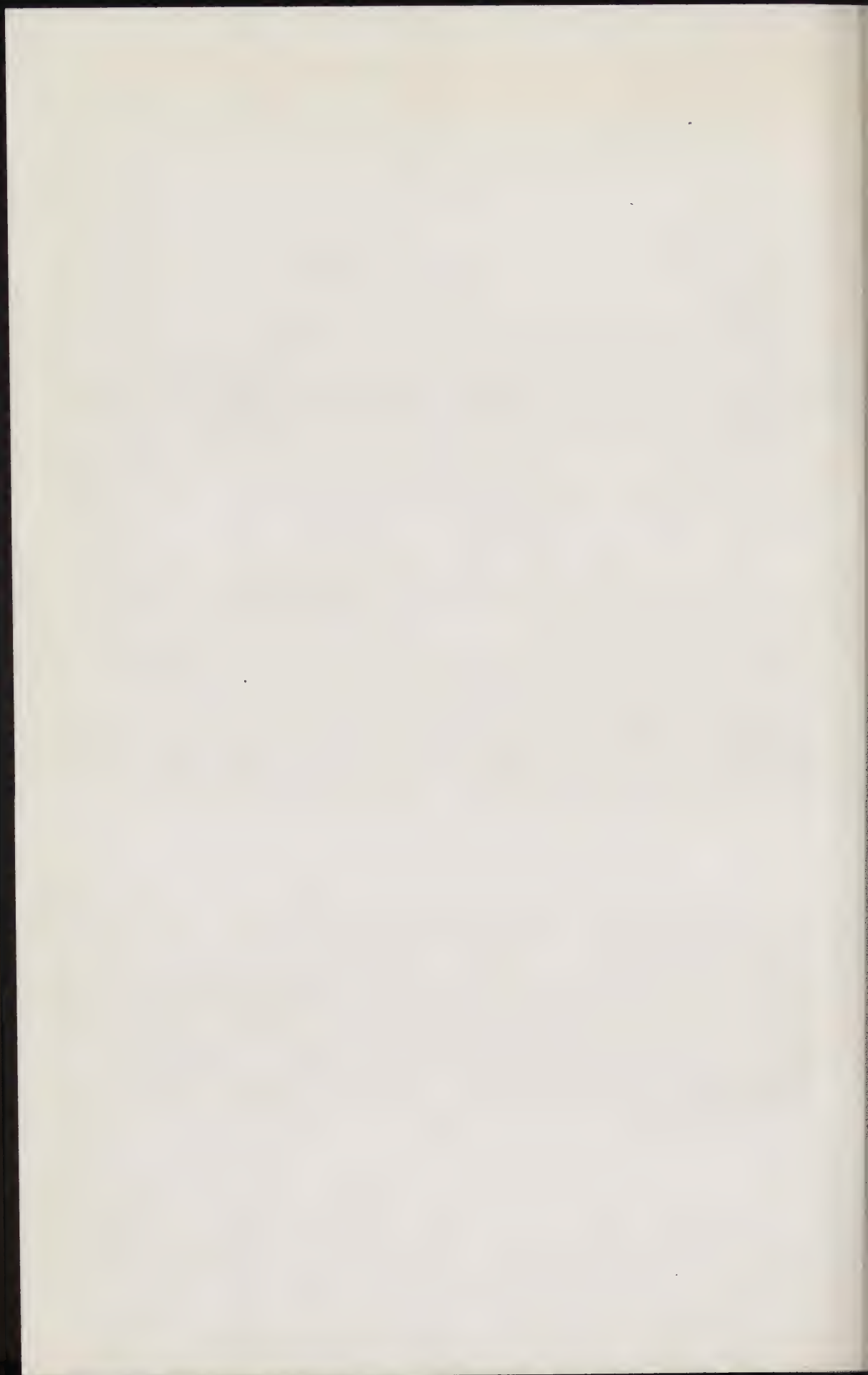
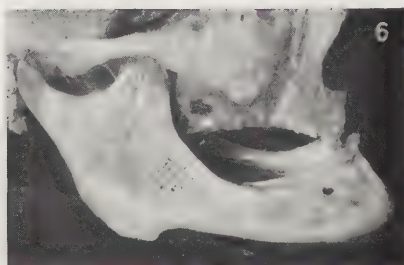
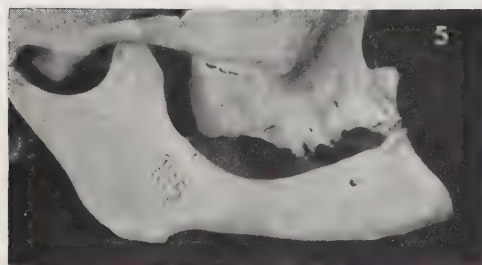
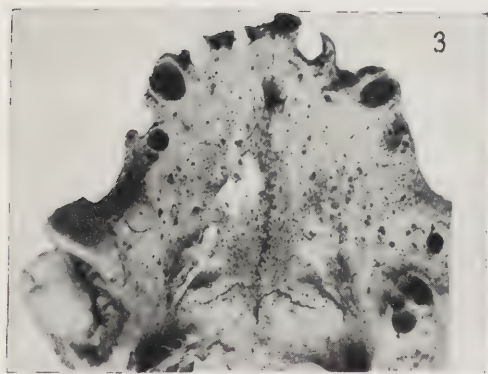
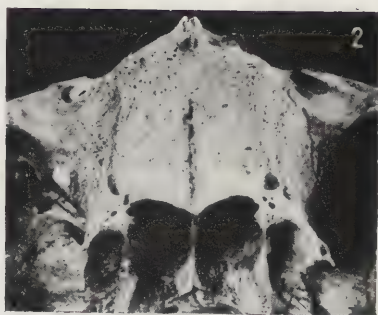
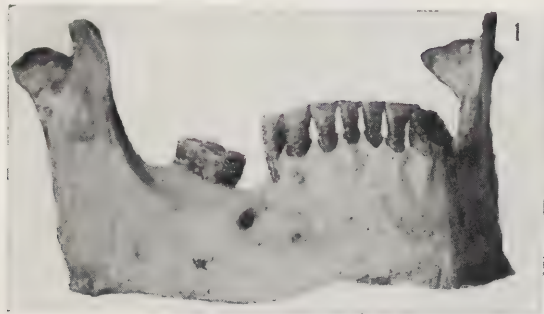
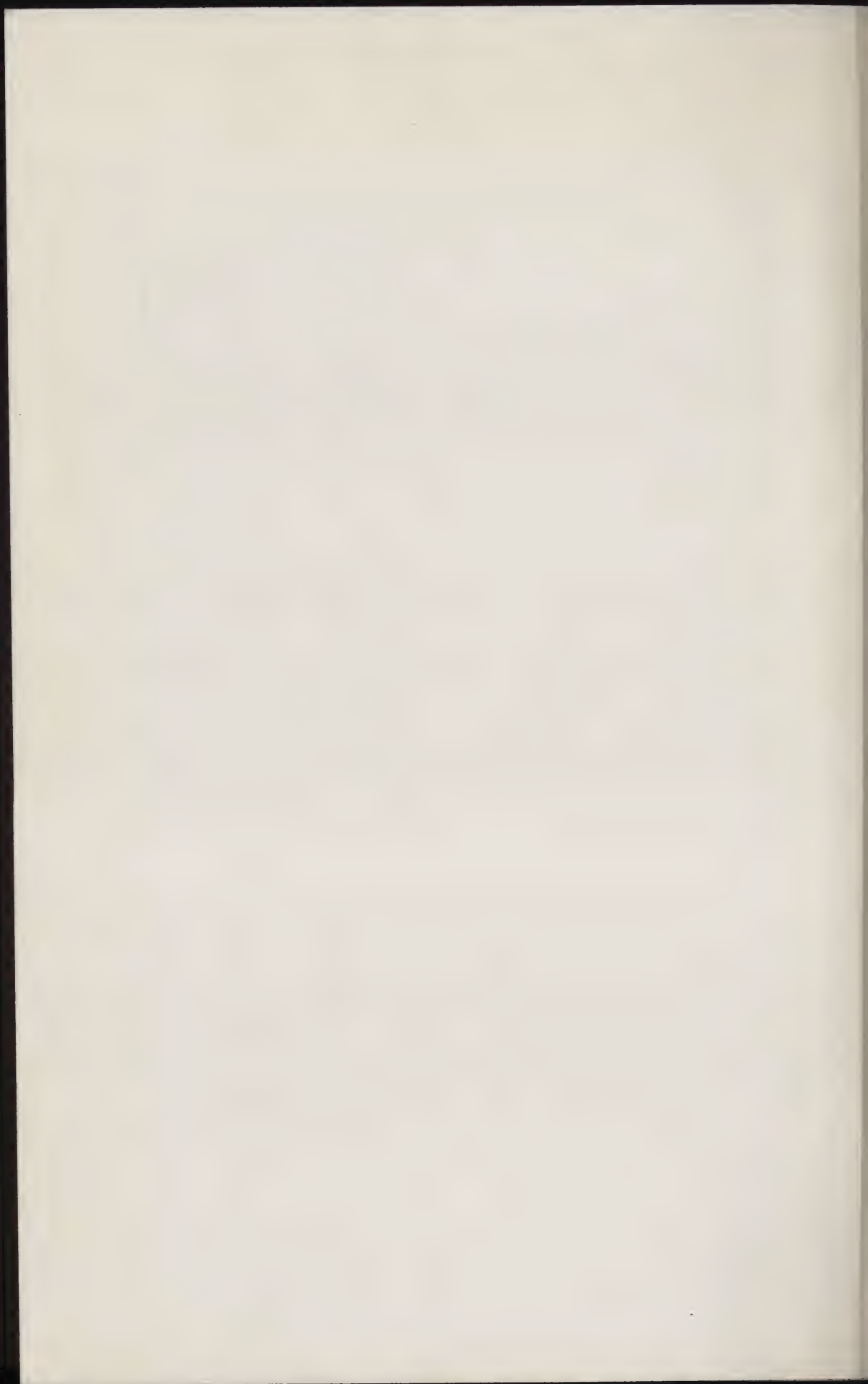


PLATE VIII.





LITERATURE

GENERAL

ON THE RELATION OF ANTHROPOLOGY AND PSYCHOLOGY. By Hrdlička (Aleš)—Address of the Vice-President of Section H, Anthropology, of the American Association for the Advancement of Science. *Science*, Feb. 27, 1920, 199-201.

"Anthropology and psychology as they are to-day, are fairly independent branches of scientific activities, with no closer actual bonds and interdependence than those that exist, for instance, between either of them and sociology or history. But in their further development and particularly that of psychology, the two branches will approach closer together until an important part of their activities will be in the same orbit."

THE RACIAL PROSPECT. By Humphrey (Seth K.)—sm. 8°, N. Y., 1920, XXI—261 pp. (Chas. Scribner's Sons, \$2.00).

"This book," the author tells us, "is written expressly to meet the new popular desire for practical knowledge concerning our racial inheritance—its workings in the every-day life about us, its bearing on human events, both past and to come. . . . Racial strength and racial decay are the most significant among all the factors which make for the rise and fall of nations. Not even wars can do more than hasten or postpone these inevitable shiftings of power from the outworn to the vigorous. Against every collective effort of man, the quality of the human stock itself finally determines which shall be the ascendant peoples. How many of us fully realize that the decisions of the Great War have yet to be tried out in the most desperate contest of peace. . . . Race-building is the key to dominance in the coming civilization." All of which may possibly be very good. But the author assumes that we are further ahead than we really are (p. XIX): "It is of the utmost significance that now for the first time in history, the race has sufficient knowledge of heredity to save itself from the blight of its own culture;" and then he quotes as "three good books on race history," Ripley's antiquated "Races of Europe;" Osborn's commendable "Men of the Old Stone Age;" and Grant's mischievously biased "Passing of the Great Race." The body of the book is devoted to a discussion of the Principles of Inheritance; the Race's Heritage; Birth-Rate and Race Values; Racial Slackers; the Fertility of the Unwanted; the Road to Decline; Human Values in Reserve; the Dominant White; Effects of the War; America; Which People shall Dominate; and the Future. The whole is an individual oration, rather than dissertation, dealing broadly, boldly and plausibly with

some well known principles and facts, but showing considerable "staining" by some of the writer's authorities. Much is "Granted" and some nations receive bad marks, especially Russia. But the last chapter, dealing with the future is quite idealistic and individual. It deals with applied Eugenics, including select, artificial, immatrimonial motherhood, for which a "vast number of women of strong inheritances" seemed to be awaiting (254-5). And at last everything, at least so for the superior portions of the white race, is on the right road.

EVOLUTION

THE PHYSICAL CONDITIONS IN THE FORMATION OF THE RACES. (In Portug.)—Mendes-Corrêa (A. A.)—*An. Ac. Politec.* Porto, 1919, XIII, 30 pp.

The author verifies in the anthropological domain the conclusions of Joel A. Allen concerning the influence of physical environment in the genesis of animal species. Profiting specially by some investigations on the population of Portugal and Portuguese colonies, he studies the geographical variations of stature, of the size of the peripheral parts (ears, feet), and of color in man, concluding that, generally, the factor "race" is predominant, but that physical, *i.e.*, environmental conditions had an important part in the primitive formation of the races. To-day the races are more stable and resist better to the external influences. Adaptation he says, is the fundamental law of life; but we must include under this the subordination of beings to their own internal conditions of equilibrium.

M.-C.

EARLY MAN

LE CANAL VERTÉBRAL LOMBAIRE DE L'HOMME DE LA CHAPELLE-AUX-SAINTS. By Anthony (R.)—*Bull. & Mem. Soc. Anthr.* Paris, 1918, IX, 18.

A brief note in correction of a recent statement that the lumbar portion of the vertebral canal of the La Chapelle man was smaller than that of the man of to-day. Author shows that throughout it is considerably more spacious.

RAPPORT SOMMAIRE SUR LES RECHERCHES COMMENCÉES DANS LES TRANCHÉES, ABRIS, CARRIÈRES DES RÉGIONS DÉVASTÉES DE LA PICARDIE.—Comment (V), *Rév. anthr.*, 1919, XXIX, 318-321.—L'ABRI DU MAMMOUTH, à Morchies. *ibid.*, 322-323.

During the late war with its unprecedented amount of excavation, particularly in Northern France and Belgium, all scholars interested in the subject of Early Man were watching for reports of important discoveries in this line. The hopes were not realized. In building trenches, subterraneans, etc., often at night, with uninstructed personnel, and under stress, much may have been passed over, and there was but little organized effort on the side of the Allies to

bring the value of possible archeological or anthropological finds to the attention of the armies, or to preserve what was found. It is understood that something more in this direction has been done by the Germans, but thus far no definite reports have reached us as to the results. Commont watched parts of northwestern France, and the articles here referred to present his brief notes on a series of discoveries or indications in the region of the famous battlefield of the Somme. They refer mostly to the Gallic or Gallo-Roman period, but in several instances, particularly at Morchies, there were finds of much older objects, dating from the Aurignacian to the Acheulean period. Skeletal remains of early man were not discovered. Commont's untimely death interfered with the exploration of the sites; but this it is hoped will not long be delayed.

OM UNDERKÄKEN I PILTDOWN-FYNDET ("Eo-anthropus"). By Ramström (Martin)—*Svenska Läkaresällskapets Handlingar*, 1916, XLII, 1223-1256, figs. 1-6.

DER PILTDOWN-FUND. By Ramström (Prof. Dr. M.)—*Bull. Geol. Inst.* Upsala, 1919, XVI, 261-304, figs. 1-12.

In two elaborate papers, the first printed in Swedish, the second in German, Professor Ramström has examined the characters of the fossils which have been associated to form the genus *Eoanthropus*. While the Swedish article includes some details that are not repeated in the later publication the German article contains the author's final conclusions. It alone is referred to in the following review.

These conclusions are that the skull represents a man which most nearly resembles the Aurignac type (Combe-Capelle) and that the jaw and cheekteeth have no human characters whatever; they represent a chimpanzee whose peculiarities, so far as they are shown by the specimen, come within the range of variation of living African members of the genus *Pan*. These results were reached, the author explains, before he had seen my paper on the subject, in Smithsonian Miscellaneous Collections, vol. 65, No. 12, no copy of which was received in Upsala until his article was in press. While our opinions are essentially alike Professor Ramström's course of reasoning is not exactly the same as mine, and his material for comparison with the casts and published accounts of the fossils is entirely different (jaws of about 20 chimpanzees and jaws or records of several hundred human subjects.) A double significance therefore attaches to the similarity of results.

Readers of the American Journal of Physical Anthropology are so fully acquainted with the Piltdown controversy (see Vol. 1, No. 1, pp. 25-52) that no detailed analysis of the present paper is necessary. Special attention may be directed to the comparison of the braincase with that of the Combe-Capelle skull (pp. 273-277, figs. 3-5), to figures 9 and 10, in which the original drawing of the jaw is shown together with the subsequently published photograph, and to the

detailed study of the breadth-length index of the crown of the first and second lower molars in men and chimpanzees. This index (table 2) appears to furnish characters about as important as the ratio of crown height to crown breadth. In the chimpanzees it ranged from 74.6 to 90, in man (including such diverse types as Negroes, Lapps, Australians, recent Swedes, and all the available specimens of Pliocene races) it ranged from 90 to 113. For the Piltdown teeth it is 83. In actual measurements (table 1) the length of the crowns exceeded the width by from 1 mm. to 3.4 mm. in all the chimpanzees examined and by 2 mm. in the Piltdown teeth; in human teeth the excess of length over width was rarely as great as 1 mm., while not infrequently the width was equal to or greater than the length. Judged by this standard the Piltdown molars obviously agree with these of chimpanzees rather than with those of men. Study of further material would probably result in extending the limits of variation for both chimpanzees and men so as to demonstrate an overlapping between the two types.¹ Nothing short of the discovery of hitherto undescribed characters can show, however, that the Piltdown molars are definitely human in their crown outline any more than they are in their hypsodonty, in the form of their pulp cavity, or in the structure of their cusps.

Finally Professor Ramström criticises a tendency which appears in much that has been written on the subject of man's descent. "Theories and working hypotheses," he says (pp. 301-302), "are clearly necessary in scientific work. But it seems to me not entirely right to 'reconstruct' *unknown* links in the chain of development according to these hypotheses and to lay such a 'reconstruction' before the public in the literature and in Museums. . . . Just two examples: *Pithecanthropus* and *Eoanthropus*. Eugene Dubois's discovery, in a river bed, picked out of a mixture of fossil bones, included: an *apelike* skullcap, some *apelike* teeth, a *manlike* thigh bone. Out of this the transition form *Pithecanthropus* was constructed. And by many it was taken as a proof of the theory that the origin of humanity (*Menschenwerden*) was led to by the upright position, and that the high development of the brain was a secondary phenomenon. . . . That was the idea about 15 years ago. Now: *Eoanthropus dawsoni*, also an assembled riverbed find, includes a *human* braincase, '*human*' teeth, an *apelike* lower jaw. Thus a contrast to *Pithecanthropus*. And at present '*Eoanthropus*' is taken as the support for another opinion as to the origin of humanity . . . the development of the brain is the primary factor. Who is right? Who stands on firm ground? Where are the real proofs?" The second question is easily answered, but the others must await the discovery of more material. Until it is found such imperfect specimens as exist may be most safely dealt with according to the characters which they themselves show rather than in accordance with the peculiarities of other fragments in proximity to which they happen to have lain.

G. S. MILLER

On this subject see Sergi, *Problemi di Scienza Contemporanea*, 1916, 113-114.

LE QUATERNAIRE DU NORD DE LA FRANCE ET DE LA BELGIQUE. By Rutot (A.)—*Bull. Soc. Belge de Géol. Paléont. & Hydrol.*, 1919, XXIX, 31-42, 151-196.

The paper is essentially archeologic and geologic, but the author's apparently successful effort to coördinate the quaternary layers of Belgium with those of northern France, as established by Commont, deserves the attention of all students of Early Man. The regret is that the author did not stop with the Quaternary.

ONTOGENY

THE LOGETIC CHARACTER OF GROWTH. By Kappers (C. U. A.)—*J. Comp. Neurol.*, 1919, XXXI, 51-67.

An article of interesting speculative nature, with the following main conclusions:

"Different factors, which play a part in our conscious experience or in the construction of our mental conceptions, as association, memory, attention, and Weber's law, are conscious realizations of general properties of life, which can be demonstrated equally in the unconscious development of the body.

"In our thinking their influence is experienced directly or realized by introspection (in perceptions by the results of certain reflexes); in the growth of the body they appear however 'in concreto.'

"Mental life and bodily development are also related in this respect that the unity of our being in both precedes external influences, which influences in both cases activate a primary 'many-in-oneness' (ego)."

HEREDITY EUGENICS

A STRAIN PRODUCING MULTIPLE BIRTHS. By Davenport (C. B.)—*J. Hered.*, 1919, X, 382-4.

Reports a family in which tendency to multiple births (twins and triplets) appeared in each of four generations. Similar tendency has long been known to exist in strains of domesticated animals.

IMMIGRATION RESTRICTION AND WORLD EUGENICS. By Hall (Prescott F.)—*J. Hered.*, 1919, X, 125-27.

"There is one aspect of immigration restriction in the various countries which does not often receive much attention, namely, the possibility of its use as a method of world eugenics."

The author's views are as follows: "Eugenics among individuals is encouraging the propagation of the fit, and limiting or preventing the multiplication of the unfit. World eugenics is doing precisely the same thing as to races considered as wholes. Immigration restriction is a species of segregation on a large scale, by which inferior stocks can be prevented from both diluting and supplanting good stocks. Just as we isolate bacterial invasions, and starve out the bacteria by limiting the area and amount of their food supply, so we can compel an inferior

race to remain in its native habitat, where its own multiplication in a limited area will, as with all organisms, eventually limit its numbers and therefore its influence. On the other hand, the superior races, more self-limiting than the others, with the benefits of more space and nourishment will tend to still higher levels."

All that remains is to show the inferior races, scientifically as well as legally, and define their inferiority.

BETTER AMERICAN FAMILIES. By Key (Wilhelmine E.)—*J. Hered.*, 1919, X, 11-13; 80-83; 107-110.

Three short articles of eugenic nature pointing, respectively, to 1), Heredity in its relation to social selection in the formation of distinctive American strains; to, 2), The story of a family belonging to the so-called middle class which in the course of generations has broken up into lines differing widely in social worth; and 3), Showing how the level of a trait or trait-complex may be raised through marriage selection.

TWINS. The December number, 1919, of the *Journal of Heredity* is devoted to TWINS. There are articles on 'TWINS' by Dr. Fairchild (387-398); 'RESEMBLANCE AND DIFFERENCE IN TWINS' by Dr. C. H. Danforth (399-409); 'PHYSICAL CORRESPONDENCE IN TWO SETS OF DUPLICATE TWINS' by Dr. Harris H. Wilder (410-421); 'CARRIERS OF THE GERM PLASM' (422); 'TWINS PROVE THE IMPORTANCE OF CHROMOSOMES' by Dr. Frederick Adams Woods (423-425); and "DEFINITION OF HEREDITY—'NATURE vs. NURTURE' NOT A GOOD EXPRESSION" by Dr. Frederick Adams Woods (426). In addition there are many good illustrations showing both similar and dissimilar twins.

Dr. Fairchild lays especial emphasis on "the importance of twins as furnishing evidence of the limitations of environment. . . . In all our experiments in education and civic improvements and in our dealings with different races we are always hampered by our ignorance of that great unknown quantity, heredity, and its influence on the people with whom we are dealing. . . . Identical twins are the only human beings in the world who have exactly the same heredity. If we can find out the characteristic ways in which they remain the same throughout life, the qualities and habits and mannerisms which persist unchanged in them both, in spite of their living in entirely different surroundings, we shall know much more than we do at present about what attributes are hereditary and fixed and what are those which we can hope to modify by environment and education."

Identical twins are the product of the division or split into two of the original parent cell, the two halves growing into separate individuals, with exactly the same heredity. They are always of the same sex and always resemble each other to an extraordinary degree throughout the whole of their lives. "Fraternal twins who do not resemble one another, and who may not even be of the same sex, are the product

of two unions of two different mother and father cells, and have simply happened to be born at the same time. There are cases where two of triplets appear to be identical twins and the third to have originated from a separate cell. Cases of identical quadruplets are theoretically possible by assuming that the fertilized cell splits into four quarters. If one of these failed to grow, identical triplets would result." Attention is called to the interest and importance of a study of the numerous photographs of twins recently obtained by the American Genetic Association. Some of these photographs are published to show the force of heredity.

Dr. Danforth reminds us that "twins that look and act alike attract attention first, while dissimilar ones are apt to be overlooked." Physically, as well as otherwise, they latter may differ more or less in every respect. "So far as can be judged by the answers, other physical traits follow the same general rule as those already mentioned—almost complete identity in some cases, and wide divergence in others. In general, similarity with reference to one trait is correlated with similarity in reference to most other traits. Rarely are there only a few points in common: still more rarely, what are otherwise similar twins may be characterized by one or two points of difference. As an illustration of the latter class, there may be mentioned a pair which in a baby show were scored as identical except for the shape of the occipital region of the head. *Physiological Traits*. Such manifestations of the general make-up as gait, sound of the voice, reaction to foods, susceptibility to disease, all show a distribution similar to that of the purely physical traits. One pair of twins state that bananas make them 'both very sick.' Another pair have no special aversion for any food but tapioca. Still another pair agree in all their likes and dislikes except for canteloupe. In other cases the lists of preferences differ very considerably." Summarizing the evidence, "there would seem to be evidence that all bodily and mental traits tend to be similar in certain (mostly uniovular) twins, but that it is not unusual in twins of either type to find differences, now in one trait and now in another. . . . Biovular twins should be expected to show resemblances in hereditary traits ranging from practical identity to wide divergence, and in any ordinary collection of photographs or data supplied by twins themselves or their friends they will *seem* to show an average degree of resemblance greater than that for brothers and sisters in general. That is, of course, entirely apart from any environmental influences that might be supposed to still further heighten their resemblances." As to why the uniovular twins are not actually identical "the answer to this query must wait" but it might "be predicted that uniovular twins would differ from each other in the same respects and to the same degree as the two sides of the body differ in ordinary individuals." The inherent constitution of the germ plasm is evidently to be ascribed a greater importance in producing these similarities and differences than the influence of the environment.

Dr. Wilder shows a "striking degree of identity in bodily measure-

ments and skin patterns of palms and soles in two sets of identical twins." The test of "bodily measurements offers an important field in the investigation of twins. They should be measured while young, before the varied experiences of after life have effected much modification, but after maturity is reached. It would be also of interest to get several series of such measurements of the same sets of twins during growth from infancy to maturity. From such studies could be learned, for instance, the effect of various illnesses undergone by one twin and not the other, and in such things could be found explanations for many of the slight lacks of complete correspondence which are out of harmony with what would be expected in genuine duplicate twins."

Dr. Woods accentuates the importance of the rôle played by the chromosomes as well as that of heredity. "This does not mean that *great* changes in the environment may not cause considerable modification in the individual; but the point is that *great* changes are not usual. The very fact that they are great is associated with their scarcity, and under usual conditions of life the physical and mental differences that we commonly observe among our fellow-beings are really due to differences traceable in the chromosomes themselves."

None of the authors, regrettably, reports any comparisons of the skeletal parts of twins, which, with the help of X Rays, could be effected in a large measure even on the living; or of their teeth, and their internal organs, all of which may fairly be expected to prove of considerable interest.

VARIATION: OSTEOLOGY

NOTE SUR L'OSSIFICATION DU MÉTACARPIEN II. By Dubreuil-Chambardel (L.)—*Bull. & Mém. Soc. Anthr.*, Paris, 1918, IX, 1-5.

The author found in 10 per cent of his cases the existence at the proximal end of the bone of a secondary point of ossification, from which the proximal epiphysis may develop. This he regards as a vestige of more primitive conditions, where the metacarpal in question was formed regularly from three points of ossification instead of two, as usual at present. He also reports a case in which the ossification of this third center resulted in the formation of a bone that remained permanently separate from the second metacarpal.

THE ONTOGENY AND PHYLOGENY OF THE STERNUM. By Hanson (Frank Blair)—*Am. J. Anat.*, 1919, XXVI, 41-115.

A valuable contribution. The conclusions of the author deserve to be quoted in full: "There is at present a median ventral rudiment, derived from the coracoids, which may be identified as a presternum as far back in the vertebrate series as the shark, and can be followed up through a ganoid, a teleost, a dipnoan, and from there on through the Tetrapoda. In all cases of vertebrates, and as high as man in the Mammalia, there is in the embryo or throughout life a continuous girdle across the ventral side and connecting the two scapulæ above. This girdle in its ventral aspect is in the most intimate relation to the anterior

part of the sternum; sometimes the mesenchymatous material passes over insensibly from one structure into the other without any line of demarkation; or at most, adults of Amphibia and Reptilia, there being but a suture between the two parts. In all these forms from the lowest to the highest, the relation of sternum and ribs is purely secondary and the result of a comparatively late fusion of the two structures in the embryo. The presence or absence of ribs does not seem to effect the development or size of the sternum in any degree. Plural ribs extending to the ventral side of the body are a recent acquisition of the vertebrates, while the shoulder girdle and sternum are coexistent and intimately related from the earliest appearance of the Gnathosomes. The number of ribs reaching the sternum varies from zero to a large number; sometimes the ribs are attached to the anterior part of the sternum, again exclusively to the posterior part, but apparently whatever the number or relation of ribs, the sternum remains unaffected, indicating strongly its independence of the costal cartilage. The evidence presented seems to bear out the homology of the sterna throughout the vertebrates; therefore, to classify them as coracoidal for the lower groups, and costal for the higher is unnecessary and artificial, for in the Amniota the sternum is as truly coracoidal in origin as it is in the Ichthyopsida. The mesosternum and xiphisternum are two backward prolongations of the coracoidal presternum, sometimes uniting in the midline (some reptiles, birds and mammals), again remaining distinct as horns or bars (some Amphibia, some reptiles)."

On the whole therefore, it may be said that "the sternum is a homologous structure throughout all groups of vertebrates, and occurs in forms ranging from *Hexanchus* up to the highest mammals. The anterior element of the sternum has its origin in common with the shoulder-girdle, and in the embryo or throughout life is in intimate relation to the coracoids. The sternal bands are derivatives of the anterior median rudiment, and may be secondarily, but never genetically, associated with ribs."

THE PROCESSUS FRONTOSPHENOIDALIS OF THE ZYGOMA AND ITS BEARING ON THE CONFIGURATION OF THE ORBIT. By Oettekink (Bruno). *Anat. Rec.*, 1919, XVII, 25-44, 3 pl.

The author has examined the processus frontosphenoidalis of the zygoma in skulls of three widely different races (Swabian, Eskimo, Negro), and of the anthropoid apes. Special methods were employed to show the differences of form and position of the process. Its bilaterally symmetrical shape could be stated in orang-utan and gorilla, while that of *Hylobates*, chimpanzee and man show the concavity of the anterior border and the convexity of the posterior. Different stages of recession in lateral projection were also noticeable, in the order Eskimo, Swabian, Negro in man, while the apes proved fairly equal with the exception of the orang-utan. The latter's anterior border of the process exceeded in lateral projection the medial

measuring point of the orbital width by 2 mm. The author speaks here of "frontality of the orbit," which in man is quite pronounced in the Eskimo. As to the horizontal mid-orbital cross-section, it appears that in man the more pronounced recession of the process combines itself with the proportionately pronounced erection in the horizontal sense. This is doubtful in the apes.

B. O.

THE NOSE, PARANASAL SINUSES, NASOLACRIMAL PASSAGEWAYS AND OLFACTORY ORGAN IN MAN. By Schaeffer (J. Parsons)—large 8vo, Philadelphia, 1920, XXII, 370, 204 illustr. (P. Blackiston's Son & Co., \$10).

The object of this elaborate and well printed monograph is "to present a study of the embryology, development and anatomy, both microscopic and macroscopic of the human nose, the paranasal sinuses, the olfactory organ and certain other ancillary structures." In this Professor Schaeffer has succeeded beyond any other author who has thus far dealt with these particular structures. Yet the work, as the writer himself frankly acknowledges, cannot be regarded as the final or complete word regarding the structures under consideration. A most attractive field, now neglected, will be that of the anthropological differences in the various parts, and as we now possess ample facilities, at least so far as osteological material is concerned, for their study, it is hoped that Dr. Schaeffer may soon extend his investigations in this promising line. As it is, the book will serve as a reliable textbook to the student of the structures dealt with, and as a reference work to the medical practitioner.

CERVICAL RIBS. By Seki (K.)—*Iji Shimbun* (Jap.), Jan. 25, 1918.

The author reports a case of pleurisy with effusion first on the left and then on the right side, due [?] to bilateral cervical rib. In the left supraclavicular fossa a bony tumor could be felt. On X-ray examination the transverse processes of the 7th cervical vertebra were seen to be well developed, and a small rib was articulated to each. The right rib was only about one third the size of the left rib.

SEVERANCE COLL. REVIEWS.

THE ANATOMY AND PHYSICS OF THE TEMPORO-MANDIBULAR JOINT.—Wilson (George H.), *J. Nat. Dent. Ass.*, 1920, VII, 414-420.

The objects of the paper are a demonstration that "the mandible is not a lever of the third class;" to detail the evidence "upon which this statement is based and thereby establish its soundness; also to direct attention to its far reaching importance in prosthetic dentistry."

TEETH

AN INSTANCE OF FOURTH MOLAR. By Fledman (M. H.)—*Dent. Cosmos*, 1919, LXI, No. 11, 1096.

Shows a radiograph of a portion of the left lower alveolar area of "the mouth of a young woman of twenty years of age. The film clearly indicates that there are a first and a second bicuspid, an edentulous space whence her sixth-year molar was extracted some time ago, and then follow, in straggling array, three molars. The last molar on the film is undoubtedly a fourth molar, and impacted in good measure."

AN INTERPRETATION OF ANGLE'S CLASSIFICATION OF MALOCCLUSION OF THE TEETH, SUPPORTED BY EVIDENCE FROM COMPARATIVE ANATOMY AND EVOLUTION. Hellman (Milo)—*Dent. Cosmos*, April, 1920; sep., 20 pp., 21 fig.

On the basis of extensive studies on the human subject, as well as comparative, the author comes to the conclusion that, "in view of the evidence adduced a uniform and definite decision as to a correct classification of occlusal anomalies can only be reached by revising the manner of procedure. This can be accomplished by the elimination of the buccal aspect of the cusp relationship and by the adoption in its stead of the lingual cusps of the upper molars and the occlusal fossæ of the lower molars. For it must be emphasized that these are the only reliable distinguishing features, because they are the most primitive landmarks of occlusion still retained in the dentition of man."

REPORT ON A STUDY OF SKULLS AT PEABODY MUSEUM, HARVARD UNIVERSITY. Presented from the Point of View of an Orthodontist. By Leavitt (Philip A.)—*J. Dent. Research*, 1919, I, 463-476.

A communication, "presented from the point of view of an Orthodontist." The conclusions are as follows: "Knowledge of the Cope-Osborn theory of trituberculy is valuable for the dentist, if for no other reason than that it broadens his point of view. It also affords additional means of determining right from left molars, the talonid being always the posterior palatal cusp. The plane of occlusion, as others have already shown, always has a forward and downward inclination. This angle should be considered and shown in the construction of plaster models, and in the study of the active forces in and about the oral cavity. The strengthened portion of the zygomatic process in the superior maxilla constantly encloses, and centers within its strongest part, the roots of the upper first permanent molar in adults. This relation suggests a means of determining the normal position of these teeth in the maxilla. From the point of view of the orthodontist, the many variations both racial and individual that exist in the forms and dimensions of the teeth, face, palate and skull as a whole, and the lack of constant interrelations between these forms and dimensions, show that orthodontic treatment of the individual patient

must be based on the conditions in that individual. Even correlations within a group or race may not be applicable to the individual."

COMPARATIVE STUDIES ON THE CURVE OF SPEE IN MAMMALS, WITH A DISCUSSION OF ITS RELATION TO THE FORM OF THE FOSSA MANDIBULARIS. By Masaru Nagao—*J. Dent. Research*. 1919, I, 159-202.

"The line touching the summits of the buccal cusps of the bicuspid and molars was carefully studied on the skulls of numerous mammals. According to the nature and form of this curved line, three types may be distinguished; namely (a) a curved line which corresponds to the arc of a circle with its convexity downwards (the curve of Spee); (b) a curved line which, possessing several maxima, resembles an undulating curve; and (c) a type which is best represented by a straight line. The first type may be further divided into two kinds; one in which, in its backward extension in the projection plane, the curved line touches the anterior face of the articular surface of the condyle; and another in which the curved line does not do this. In the case of the 'center angle' the following relations were found: Among the primates, *Simia satyrus* has the greatest angle (35.6 degrees), *Macacus nemestrinus* the smallest (16.3 degrees), while man with 28.6 degrees occupies an intermediate position in the order. Among the artiodactyla, *Porcus babyrussa* has the greatest angle (31.3 degrees) and *Lama huanacho* the smallest (23.4 degrees). *Rhinoceros* was found to possess the greatest angle (38.4 degrees) among all the mammals examined. Neither the curvature of the curve of Spee nor the 'center angle' of the curve increases or decreases regularly according to the zoological order to which the animal belongs. Neither the curvature nor the magnitude of the 'center angle' of the curve of Spee varies proportionately with the size of the teeth, the size of the skull, or the degree of prognathism of the skull. A reciprocal relation between the value of the 'center angle' of the curve of Spee and the value of the angle of the line of articulation to the basio-nasal line (articular basio-nasal angle), was found in the primates, with the exception of man. The real significance, physiological and anatomical, of the curve of Spee is not clear."

VARIATION: APPENDAGES; SOFT PARTS (THE HAIR AND EYEBROWS OF KOREANS). By Kubo (M.)—(*J. Korea Med. Soc.*), Dec. 26, 1917, 61-88.

Short hair (0.5 to 1.3 cm. in length): This included the eyebrows, eyelashes, hair of the nostrils and ears. Koreans chiefly were studied.

EYEBROWS: Each eyebrow has been studied according to Bertillon's method.

The distance between the brows in Koreans: wide, numerous; medium, next in frequency; close, very few.

Height of eyebrow (above the eye): high, common; low, very few. This is the rule with Chinese and Japanese, wherein they differ from Europeans.

Direction of eyebrow (ages 20 to 40). Oblique inward; in men, 66 per cent; in women, less frequent. Straight; in men, 26 per cent; in women, more frequent. Oblique outward; in men, 8 per cent; in women, also rare.

Shape of eyebrow: curved, numerous; straight, next in frequency; wavy, very rare.

Length and Width; average measurements of ten men and five women. Male: right, 52.7 long and 13.1 wide; left, 53.8 long and 14.2 wide. Female: right, 49.2 long and 13.4 wide; left, 49.0 long and 13.4 wide. In eight Japanese men the measurements averaged: right, 55.4 long and 12.3 wide; left, 56.8 long and 12.7 wide.

Density of eyebrow. In general, the dense type is common. Among 117 women the dense type reached 48 per cent; medium type, 30 per cent; sparse, 22 per cent. The eyebrows are denser in the dark-haired southern races than in the light-haired northern races.

Number of hairs in eyebrows. The author counted the number of hairs in the eyebrows of ten Korean men and five women. Average number in males: right, 576; left, 586. Average number in females: right, 430; left, 450. Average number in eight Japanese men: right, 638; left, 677. The middle portion of the eyebrow is the densest; the medial part is denser than the lateral.

Length of the hair. Average males, right, 9.6 mm., left., 9.9 mm. Average length in females, 8.2 mm. each side. Average in Japanese men: right, 9.6 mm.; left, 8.6 mm. left. The hairs may grow longer in old individuals.

The direction of growth of the hairs. In the medial portion the hairs grow obliquely upward forming an angle of 20° to 30° with the line of the eyebrow; in the lateral portion they grow obliquely downward, parallel to the line of the eyebrow. In Koreans the portion of the brow which sweeps upward is wider than that which sweeps downward.

The color of the eyebrows is usually black or nearly black, but a little lighter in Koreans than in Japanese. Rarely it is brown or reddish-brown.

Quality of the hairs of the eyebrow. In Koreans the hairs of the eyebrows are usually of the "brush type;" rarely "bristly."

Shape and diameter of the hairs on cross section. In Koreans, Chinese, and Japanese, the eyebrows are elliptical on cross section, and are smaller than the hair of the head, whereas in Europeans they are coarser than the hair of the head.

Measurements	No. of Hairs	Long Diameter	Short Diameter	Ratio of Short to Long Diam.
Six Chinese men	69	0.108 (0.07-0.14)	0.074 (0.04-1.12)	67.7
One Japanese woman . . .	5	0.084 (0.06-0.10)	0.056 (0.04-0.07)	66.6

In Chinese (and in the Japanese woman) the eyebrows are coarser than the eyelashes, but finer than the hair of the scalp, axilla, and

pubes. The ratio of the short to the long diameter of the eyebrow is less than that of the hair of the scalp and beard, much less than that of the eyelashes, but larger than that of axilla and pubes.

SEVERANCE COLL. REVIEWS.

A PRELIMINARY QUANTITATIVE STUDY OF THE PURKINJE CELLS IN NORMAL, SUBNORMAL, AND SENESCENT HUMAN CEREBELLA, WITH SOME NOTES ON FUNCTIONAL LOCALIZATION. By Ellis (Robert S.) —*J. Comp. Neurol.*, 1919, XXX, No. 2, 229-252.

The main purpose of the paper is to show the numerical differences in Purkinje cells in normal, subnormal, and senescent cerebella. "From the data submitted it is evident that in cases of extreme mental defect, due to agenesis or to the early action of toxins during intra-uterine life, there is an evident deficiency in the number of these cells. Similar reductions in the number of cells due to various causes are found in senescence (and paresis). In the subnormal cerebella the evidence indicates that the normal number of cells has never been present in a developed form. In the senescent (and paretic) cases however, the small number is due to disintegration. The anterior lobe of the cerebellum shows the greatest deficiency in cells in both the subnormal and senescent cerebella. The biventral lobe shows the greatest variation in both types of cases. In some cerebella it shows the greatest loss of cells and in others the least loss. The differences between the two hemispheres in respect of cell number average less in subnormal cerebella than in normal ones. This probably has a relation to the differences in the degree of unilateral dexterity found in normal and subnormal individuals, *i.e.*, normal people are usually more distinctly right (or left) handed than are the subnormal, who tend to be more ambidextrous. The deficiency in cell number affords in large measure an explanation of the motor defects found in subnormal individuals. It shows furthermore that in idiocy and in imbecility we may expect to find the whole brain defective rather than the frontal lobes only, while the higher grade of defectives (morons) probably show very slight deviations from the normal."

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GRAPHIC REPRESENTATION OF THE INSIDE OF THE SKULL WITH SPECIAL REFERENCE TO THE PITUITARY FOSSA

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The different graphic methods employed for the outside of the skull have not as yet been used in studies of the inner surface. As will be shown presently it is worth while trying these methods for this purpose.

One of the writer's students, Miss M. Doškova, undertook the profiling of the inner surface of various human crania, both normal and pathological, and some crania of apes. For this object Martin's instruments were used, and the method followed was that elaborated for the outside of the skull by the brothers Sarasin. The inner profiles, or endocraniograms as they may be called, were made on skulls cut horizontally in the following manner: The crania were placed on a craniophore, fixed there in the Frankfort plane, with the line from the inferior border of the orbit to the superior border of the external auditory meatus horizontal, and a mark parallel to this base-line was made on the vault. The calvarium was then sawed off along this line, and the inner profiles of the skull in the frontal and sagittal directions were drawn; both parts of these when united, gave the full profile of the inside, except a small interruption of about 2 mm. on each side, due to the saw-line.

The drawing of horizontal profiles is not feasible in skulls opened in the ordinary way, though it could be made by a needle specially curved for this purpose; but it is readily possible in skulls cut in the frontal or sagittal direction.

The following profiles were drawn for the present studies:

I. Endocraniograms in the frontal plane (see fig. 1):

- (1) Profile through the foramen cæcum of the frontal bone;
- (2) Profile half-way between (1) and (3);
- (3) Profile through the foremost point of the ridge dividing the frontal cerebral fossa from the temporal cerebral fossa;

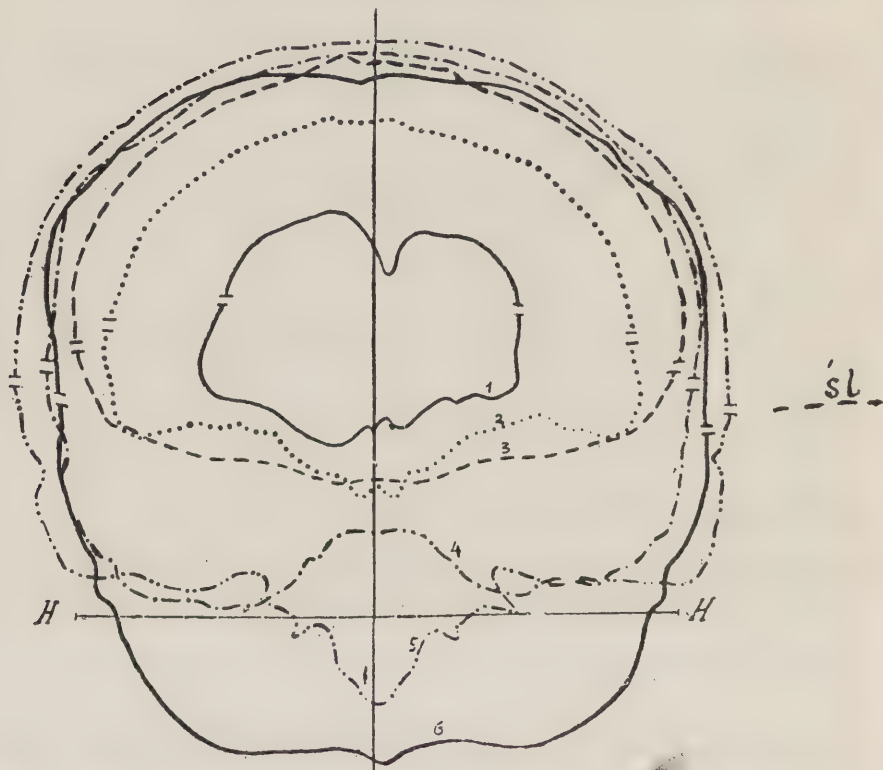


FIG. 1. Skull of a Normal European. 1, 2, 3, 4, 5, 6 The frontal endocraniograms. *sl*—Saw-line; *H-H*—Base-line of the skull.

- (4) Profile through the middle of the sella turcica;
- (5) Profile through the most anterior point of the foramen magnum (basion);
- (6) Profile through the most posterior point of the foramen magnum (opisthion).

II. Endocraniograms in the sagittal plane (see fig. 2):

- (1) Median profile.

- (2) Profile through the middle of the maximum breadth of the respective half of the endocranium;
- (3) Profile either through the deepest part of the fossa for the occipital lobe of the brain, or through the deepest part of the fossa for the cerebellum.

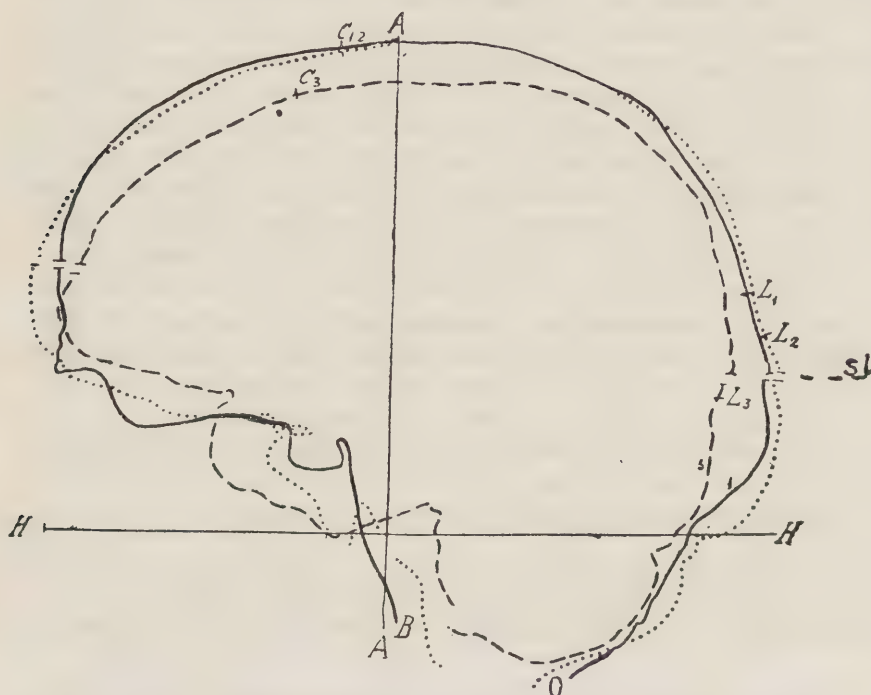


FIG. 2. Skull of a Normal European. 1, 2, 3 The sagittal endocraniograms, with marks where the coronal—*C*—and lambdoid—*L*—suture have been met. *sl*—Saw-line; *H-H*—Base-line of the skull; *B*—Basion; *O*—Opisthion; *A-A*—Vertical line through superior border of external auditory meatus.

The endocraniograms drawn in the manner described above on different crania of normal Europeans, and on those of a negress, an Eskimo and an American Indian with artificial deformation of the skull, show that the method is suitable for illustrating different racial peculiarities; the results of artificial deformation, and furthermore asymmetry of the endocranium and hence the brain. They also give us an idea of the relations of the brain to the whole conformation of the skull, and to the different organs of the head in both normal and patho-

logical cases (as for instance in the head of a microcephalic individual.) These drawings make it further possible to study the proportions of different parts of the brain, especially those of its base, and the detailed configuration of the basis cranii, as for instance the fossa for the frontal lobe, the inclination of the supraorbital plane, the overlapping of the cerebellar hemispheres by the occipital lobes of the brain, etc.

Besides the above, a special topic was studied by means of these endocraniograms. M. Boris Goldfarb, one of the writer's pupils, undertook the measurement and description of the pituitary fossa, and the study of its proportions with reference to the cranial cavity. It is easy to note on the endocraniograms the length and depth of this fossa, and hence to get accurate data for comparison with the measurements of the endocranium. The diagrams were drawn on special paper with millimeter squares which can readily be counted, or on white paper, in which case the plane of the pituitary fossa was measured by a planimeter and compared with the whole endocranium measured in the same way. The latter method affords also good means of measuring the pituitary fossa on X-ray plates.

Twenty-seven skulls were used in the studies of the pituitary fossa. They were divided into three groups, according to the dimensions of the median plane of the whole endocranium. The results of the observation are shown briefly in the following table:

PROPORTION OF THE PITUITARY FOSSA, IN RELATION
TO THOSE OF THE ENDOCRANIAL CAVITY

Normal Skulls	Number of Cases	EXTENT OF THE MEDIAN PLANE				The Median Plane of the Pituitary Fossa in Per- centage of That of the Whole Cranium	
		Of the Whole Endocranium		Of the Pituitary Fossa			
		Average	Range of Varia- tion	Average	Range of Variation	Average	Range of Variation
		In Square Millimeters					
Group I. . . .	9	11,468	9314-12836	76	29-47	0.67	0.45-0.90
Group II. . . .	9	13,620	12894-14232	84	33-57	0.62	0.48-0.85
Group III. . .	9	15,066	14254-16680	78	32-54	0.53	0.42-0.76
Total. . . .	27	13,320	9314-16680	79.2	29-57	0.61	0.42-0.90

The average area of the median endocraniogram of the pituitary fossa is seen to be 79.2 square mm., and that of the whole endocranium 13,320 square mm., which shows that the median plane of the pituitary fossa is 0.61 per cent of that of the whole cranial cavity.

It is of interest to note that the pituitary fossa in the second group of specimens, the middle sized skulls, shows absolutely the largest size, whereas the largest skulls of the third group show the smallest figures. This is in accordance with Hrdlička's¹ statement, that—"The size of the pituitary fossa, as represented by the module [mean diameter] increases with the size of the skull, but apparently the increase ceases after the average size of the skull is passed."

To better compare our skulls in this respect with those described in Hrdlička's paper, which gives the first comprehensive measurements of the fossa, Mr. Goldfarb was instructed to follow Hrdlička's method and to get by direct measurements the length, width and depth of the sella turcica, and hence the three constituents for the module (length + width + depth).

3

The results correspond closely to those of Hrdlička and show that the greatest module of the pituitary fossa occurs in skulls with medium circumference or medium cranial module.

The figures are as follows:

Normal Skulls	Circumference of Skull	Module of Pituitary Fossa	Module of the Whole Cranium	Module of Pituitary Fossa
	<i>cm.</i>	<i>mm.</i>	<i>cm.</i>	<i>mm.</i>
Group I.	47.5-49.9	10.9	14.2-14.5	11.0
Group II.	50.0-51.9	11.0	14.6-15.1	11.1
Group III.	52.0-54.0	10.8	15.2-16.5	10.7

These interesting relations of the size of the pituitary fossa to the size of the skull were corroborated by a third method, namely by measuring the capacity of the pituitary fossa. To obtain this capacity we proceeded in the following way: the pituitary fossa was first varnished, then oiled, and after that filled with plastilina, which was levelled with a spatula on both sides of the fossa just above the inner ridges of the carotid sulci and on the top from the dorsum sellae to the inner ridge of the tuberculum sellae. Then the lump of plastilina was removed, weighed and its specific density determined, by which it was then easy to get the capacity of the fossa. This capacity was compared with the capacity of the whole cranium obtained also according to the method of Hrdlička.² This comparison gave us the following results:

¹ Hrdlička (A.).—Dimensions of the Normal Pituitary Fossa or Sella Turcica in the White and the Negro Races. *Arch. Neur. & Psychopath.*, 1898, I, No. 4, 679-698.

² See his *Anthropometry*, 8°, Wistar Inst., Phila., 1920.

Normal Skulls	A	B	C
	Average Capacity of the Skull in Cubic Cm.	Average Capacity of the Pituitary Fossa in Cubic Mm.	"B" in Percentage of "A"
Large skulls.....	1499	708.83	0.474
Medium skulls.....	1364	840.96	0.611
Small skulls.....	1236	765.77	0.621
Total averages.....	1352	767.96	0.576

These figures show that the capacity of the pituitary fossa amounts to about three quarters of a cubic centimeter, but may vary from a half to one and a half of a cubic centimeter. On the average the largest fossae, both absolutely and relatively, are found in medium sized skulls, whereas the smallest, again both absolutely and in relation to the size of the cranial cavity, are met with in the largest skulls.

Mr. Goldfarb was requested furthermore to investigate these relations in a series of skulls of degenerates, insane and criminals among the collections of the Institute, and it was found that in general the dimensions of the pituitary fossa were considerably higher in these than in skulls of normal people, though the whole capacity of the crania in the abnormals was rather high.

Fitzgerald's¹ statement that the length of the pituitary fossa is reversedly proportionate to the anterior part of the basal length of the skull was confirmed; furthermore it can be stated that the posterior part of the basis cranii shows the same relations.

The importance of the pituitary gland for the development of the body appears evidently in the relations of the size of the pituitary fossa to that of the cranium, and invites further investigation, especially in the case of various classes of degenerates.

¹ Fitzgerald (D. P.)—The Pituitary Fossa. *J. Anat. & Physiol.*, 1910, XLIV, 231.

THE FORM OF THE PAROTID GLAND IN JAPANESE

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Owing to its simple shape and easy access, the parotid gland has been extensively studied. Yet there are many points concerning the organ about which discrepancies still exist. Especially almost no attention has been given to the parotid gland of other races than Europeans, though Pösch gives a brief note on the parotid gland of a Bushman, and Fisher reports on that of the Damara, both pointing out that the parotid glands of these races are large.

This paper deals with a study of the parotid in the Japanese. For a comparison the gland was studied also in five Europeans, three Chinese, and four apes (*Macacus*).

MATERIAL

The material used was as follows:

	Male		Female		Totals	
	Heads	Glands	Heads	Glands	Heads	Glands
Fetuses.....	2	3	4	4	6	7
Infants.....	2	3	4	7	6	10
Adults.....	13	22	6	8	19	30
Total.....	17	28	14	19	31	47

The bodies were originally destined for another purpose, in consequence of which deformities of the gland were present in some instances. In such cases use was made of the normal side only.

The outside observations on the gland were made on both sides of the head; the study of the deeper parts on one side alone. One gland was used from each of the five European and three Chinese heads, which were all from males and belonged to healthy individuals who did not die of sickness. These heads were first frozen, then exposed to formol vapour and later preserved in alcohol. The Japanese material

¹ The writer wishes to express his grateful obligation to Prof. B. Adachi for the use of the European and Chinese material and for his courtesy in reviewing this paper.

was fixed by injections into the arteries of formol-alcohol or potassium bichromate-formol, or by immersion of the head in 5% formol.

The four macaque heads were preserved in alcohol.

FORM AND SIZE OF THE PAROTID GLAND

The study of the gland naturally divides itself into that of its external part and its retromandibular process; the external part is the portion seen on the removal of the superficial fascia, the retromandibular process being that part which passes posterior to the ramus of the mandible.

The gland as a whole has been described as being roughly pyramidal in shape. Four surfaces can be distinguished, as follows:

1. The *external surface*, located subcutaneously and looking outward.
2. The *posterior surface*, looking backwards, and in contact with the sternocleidomastoid and digastric muscles.
3. The *antero-mesial surface*, looking forwards, and in contact with the masseter and internal pterygoid muscles. And,
4. The *superior surface*, looking upwards and in contact with the lower wall of the external auditory meatus. This is the smallest of the four surfaces.

The volume of the gland is given in the following table:

THE VOLUME OF THE PAROTID GLAND

Volume in c.c.	Japanese Infants, No. of Glands	Japanese Adults, No. of Glands	Chinese Adults, No. of Glands	European Adults, No. of Glands
5	3			
8	1			
10		2		
13		2		1
14		1		
15	1	1		
17				1
18		1		2
20		4		
23		1		
25		1		
26		1	1	
30		1		1
33		1		
35			1	
Total	(5)	(16)	(2)	(5)
Averages, c.c. . . .	8	19	31	19

The above data show that there is no significant difference in the volume of the gland of the different races observed.

LOBULATION

The outer surface of the parotid shows many small lobules which are divided from each other by connective tissue. They may be called the primary lobules. These primary lobules are often subdivided again into smaller areas, which may be designated as secondary lobules.

In situ the primary lobules appear irregularly round, sometimes elongated. The edge of the primary lobule is generally sharp, but occasionally it is blunt, in which case it has a convex appearance.

The size of the primary lobule is smaller in individuals with smaller glands, such as fetuses and infants. For the same individual the lobules are approximately of the same size on the external surface, but occasionally in the posterior part they are smaller. In most cases they overlap each other as tiles on a roof, otherwise they are placed side by side. The posterior lobules overlap the anterior ones successively, but in a few cases the reverse may occur. Seldom in the subauricular part the lobules may be seen to be arranged radially and overlapping successively the peripheral ones.

Due to the small amount of connective tissue between the secondary lobules, their borders appear on the surface like straight lines. They differ from the primary lobules in always lying side by side and not overlapping.

In a few cases the parotid gland is further partially divided by a thickening of the interlobular connective tissue. Sometimes also on the retromandibular process a part of the gland is partially separated by bloodvessels and appears like a lobe.

The primary lobules of the proximal surface are not as regularly arranged as they are on the external surface, and in consequence it is not possible here to distinguish between the primary and secondary lobules.

The gland is said to be divided into two layers by the facial nerve, but the writer was unable to verify this, as the search would have destroyed the material for further study.

RELATION TO FAT

In the newborn or infants that have well developed subcutaneous fat layer, the parotid glands appear to be largely filled with fat; but on microscopical examination both kinds of tissue, glandular and adipose, are found to be well represented. Some glands nevertheless

consist mostly of fat, in which case they are relatively large and have convex outer surfaces. Such fatty glands are never found in the adult.

THE SURFACES

1. SHAPE AND SIZE OF THE EXTERNAL SURFACE

In the two embryonic stages observed ($5\frac{1}{2}$ and $7\frac{1}{2}$ months), this surface was more or less triangular, which agrees with the drawings shown by Carmalt. In the full term fetus and in the infant it is triangular, or chestnut like, and never irregular. The superior border is just beneath the external ear, the poster rests on the sternocleidomastoid, and the anterior on the masseter muscle, the latter border being thus directed forward and upward. All three borders may be of the same length, or the anterior may be longer than the two others. In the adults the form of this surface often becomes irregular, though it may still be designated as triangular.

The external surface was measured, but as it is not always regular the diameters do not indicate direct ratio to the area of the surface. The results are shown in the next table. The "sagittal" diameter is the greatest distance between the posterior and anterior borders, which in most cases is in the subauricular region. The "vertical" diameter of the external surface is the distance between the inferior angle and the highest part of the superior border which is always located in front of the external ear.

The results show that in these respects again there is practically no difference in the glands of the different races here studied. Krause gives 4.7 and 4.0 cm. for the vertical and sagittal diameters of the external surface respectively. In the fetus and infant the sagittal diameter is greater than the vertical, even though the gland but seldom has the long anterior process, while for the adults the sagittal diameter is not greater than the vertical. This fact might be explained by the development of the gland going hand in hand with the growth of the face.

The external surface is usually said to be flat or convex. In the infants it is always convex. In two fetuses examined ($5\frac{1}{2}$ and $7\frac{1}{2}$ months) it was convex. In the adult it may be either convex or flat.

2. THE INFERIOR ANGLE OF THE EXTERNAL SURFACE

The inferior angle is the lowest point of the external surface of the gland and is formed by the junction of the anterior and posterior

borders. The value of the angle varies from 60° to 90° approximately. In the infant it is obtuse, for the sides curve outward. Notches are sometimes present in this angle, formed by branches of the facial

SAGITTAL AND VERTICAL DIAMETERS OF THE EXTERNAL
SURFACE OF THE PAROTID

Sagittal Diameter					Vertical Diameter				
Cm.	Japanese		Chinese Adults	Euro- pean Adults	Cm.	Japanese		Chinese Adults	Euro- pean Adults
	Infants	Adults				Infants	Adults		
2.9	1				2.4	1			
3.1	2				2.5	1			
3.4	1				2.8	1			
3.7	1			1	2.9	1			
3.9		1			3	1	1		
4	2	4			3.2	2			
4.1				1	3.4	1		1	
4.2	1	2			3.6	1			
4.3	1				3.8		1		
4.4	1				3.9	1			
4.5		1			4		3		1
4.6		3			4.2		1		1
4.7			1		4.3				1
4.9				1	4.5		2		
5		5	1	1	4.6		2		
5.1		3			4.7		2		
5.3		3			4.8		1		
5.4			1		5			1	
5.6				1	5.1		1		
5.7		2			5.2		1		
5.8		1			5.3		3		
6		1			5.4		2		
6.5		1			5.6		1		
7		1			6		3		
7.2		1			6.3		1		
9		1			6.5		2	1	1
					6.6		1		
					7.1				1
					7.6		1		
					(9.4?)		(1)		
Totals.....	(10)	(30)	(3)	(5)		(10)	(30)	(3)	(5)
Averages (cm.).....	3.7	5.2	5.-	4.7		3.1	5.3	5.-	5.2

nerve and the posterior facial vein. In most cases the inferior angle rests on the angle of the mandible, while in others it may be located in front, behind or above the latter. In one case a forward prolongation of the gland along the lower margin of the mandible was fused with the submaxillary gland. The writer was unable to confirm Sappey's observation that the lower angle is situated one or two centimeters below the angle of the mandible.

3. THE ANTERIOR BORDER OF THE EXTERNAL SURFACE

In general the anterior border of the external surface of the parotid is somewhat thin, as all authors agree, but sometimes it happens to be thick. This border runs forward and upward, but very seldom it is directed vertically upward, as was seen in one case where it ran up the posterior side of the ramus of the lower jaw. When the vertical diameter of the gland is short, then the lower angle of the external surface is not marked, so that it is difficult to distinguish the anterior border from the posterior, and thus only the term, the lower border, may be given. In most cases the course of the anterior border agrees with the direction of the masseter muscle, but as the direction of the muscle is not constant, this can only give an approximate indication of facts. Although the anterior border is more or less irregular, in general it takes a straight, or convex, or concave course. Sometimes it will contain a marked incisure, due to the presence of a lymph gland. According to Gerlach the anterior portion of the gland overlaps one third of the masseter muscle, while Krause says that it covers one half of the muscle. The writer agrees with both authors but wishes to point out exceptions. In one of his specimens the anterior portion of the gland covered the masseter so that but a small portion could be seen; while in another where the anterior border of the external surface of the gland ascended along the posterior margin of the ramus mandibulae, the lower part of the masseter was not covered by the gland at all.

4. THE ANTERIOR PROCESS

The B.N.A. gives no term for this part of the gland so that it varies with every author—"prolongement antérieur ou génien," Testut; "prolongement massétérien ou génien," Poirier; "facial process," Cunningham. The writer will call it the anterior process, according to Testut. Poirier believes that this process accompanies the parotid duct, takes a triangular form and extends on to the masseter muscle. Other authors make similar statements. To avoid confusion the writer will define this process as it is considered in this paper. It is that part of the parotid gland which extends forward considerably on the surface of the masseter muscle, or if the extension is slight, it is that part which shows some difference from the main glandular body by the forward direction of its course or by the presence of an incisure. Poirier and Dwight contend that the anterior process is always present, but according to the definition here given it was found only in two-

thirds of the Japanese, in two cases out of three in the Chinese and in four cases out of five in the Europeans. The process is said to be triangular (Poirier, Cunningham), or flat-conic (Testut). It will here be described in several different types. There are instances in which the process projects beyond the anterior edge of the masseter muscle and ends in an acute angle. In other cases it does not attain the anterior edge of the muscle. When it projects far enough it comes in relation with the parotid duct, and then it either extends along the upper margin of the duct, or covers the duct so that it emerges from the top part of the process. In still other cases the process does not extend far, forms a blunt angle, and assumes no relation with the duct. The material utilized for the present study never confirmed Poirier's statement that sometimes a gland has two anterior processes. Also he states that the size of the process is proportional to the size of the gland; no attempt will be made to discuss this question.

5. THE ANTERIOR ANGLE, SUPERIOR BORDER, POSTERIOR ANGLE AND POSTERIOR BORDER

The anterior angle of the external surface of the parotid is not usually well formed.

The superior border is generally irregular, runs backward, turns downward at the anterior edge of the auricula, bends around the lower side of the external auditory meatus, again runs backward and goes into a somewhat distinct posterior angle.

The height at which the superior border of the gland reaches the auricula usually corresponds to the level of the tragus, sometimes to the level of the incisura intertragica, or more seldom corresponds to the point above the tragus. In most cases the superior border attains its apex at a point nearest the auricula.

The posterior angle forms a rather acute angle which is situated between the sternocleidomastoid muscle and the posterior wall of the external auditory meatus. It is about 1.0, seldom 2.0 cm. lower than the highest part of the gland. The posterior border is usually slightly convex to straight, only seldom strongly convex and never concave. This border is not as uneven as the anterior border. Although it is situated immediately next to the sternocleidomastoid muscle, there is occasionally thick connective tissue between them. The Japanese showed but three out of forty cases where there was such thick connective tissue, European three out of five cases, and the Chinese two

out of three cases. The thick connective tissue does not extend all of the distance into the intervening gap between the gland and the muscle. According to Poirier the posterior part of the gland superimposes upon the sternocleidomastoid muscle for several millimeters. The cases here recorded showed that sometimes the gland extended over the muscle while at other times there was no such extension.

THE SUPERIOR SURFACE

The superior surface of the parotid gland is that small surface which is moulded by the approximation of the gland to the external auditory meatus. This surface is divided into an internal and external area by a crest which runs with a median inclination antero-posteriorly and fits into the bend of the cartilage of the external auditory meatus, so that it is concave in about the sagittal plane (fig. 1). This crest is not always distinct, and extends posteriorly to the posterior angle and anteriorly to the highest point of the gland situated just before the auricula. For convenience of description the two areas of the superior surface will be called here the external and the internal area, and the highest point of the gland will be the preauricular process.



FIG. 1. OF, Superior Surface; L, Crista. $\times \frac{2}{3}$, left side.

The superior surface meets the external surface in a line which describes a concave arc in a sagittal plane corresponding to the wall of the external auditory meatus. This line bends outward in a convex course which varies with the convexity of the external surface. Though the edge so formed is ordinarily distinct, sometimes it is not so perceptible.

The form of the external area of the superior surface is scaphoid in character, elongated in a sagittal direction, and its size and concavity show individual variations. Generally the external area inclines upward, sometimes very markedly, while in other cases it is merely at right angles to the external surface.

The internal area of the superior surface has no distinct medial boundary and passes to the sulcus styloideus (to be mentioned later). In a few cases there is a crest dividing the internal area from the sulcus. As was stated before, this area is separated from the external area by a crest. Posteriorly it is bounded by an edge which runs

medially from the posterior angle of the external surface. Anteriorly it is restricted by an edge which runs medially from the preauricular process. Thus the internal area appears as an irregular quadrangle. The anterior edge is usually lower than the posterior, and as a rule both edges are prominent, although sometimes the anterior edge is indistinct. These edges are usually parallel, but sometimes the anterior edge diverges from the posterior in a medial direction, while the posterior remains at right angles to the external surface. The internal area is also concave according to the form of the auditory meatus, but is inclined downward in a medial direction. Very seldom it was found to descend sharply going directly to the sulcus styloideus. The internal area also shows individual variation in size. It is thought by Symington that the part which is here called superior surface slopes downward so abruptly that it is more appropriately described as parts of the anterior and posterior surfaces than as forming a distinct surface. In the writer's opinion, although there are rare cases of steep inclination, for the most part there is a well defined surface which deserves to be classed separately.

THE MEDIAN EDGE, OR PHARYNGEAL PROCESS

The median edge is a part of the gland formed by the joining of the anterior and posterior surfaces so as to form a process which projects into the sulcus formed between the styloid process and the internal pterygoid muscle. This extension of the gland may be called the pharyngeal process. The results of the present observations agree with Poirier's and Testut's that this process is very seldom absent. Its form Poirier describes as conical, while Testut says it is papillary; at any rate it projects along the styloid process in a lip shape with a vertical elongation. The free edge is rounded and the process varies both in breadth and height. It is usually highest in the middle, but it also may be highest either superiorly or inferiorly. In order to give a definite picture of the size of the process, the height from the styloid sulcus to the top of the pharyngeal process and the breadth of the base was measured in twelve adult Japanese. The height varied from 5 to 11 mm. averaging 7 mm., while the breadth varied from 6 to 9 mm., averaging 8 mm.

According to Jefferson the gland does not extend medially beyond the styloid process, but as the above measurements indicate, the process does project beyond the styloid process. Testut states that its development is variable, so that at times it is a simple prominence

attached by a large base to the glandular body, while at other times it is a voluminous isolated lobule which is connected to the main part of the gland by a narrow pedicle. The present studies confirm the former condition, but no case was found of the latter variety.

There are discrepancies concerning the relation between the pharyngeal process of the gland and the pharyngeal wall. Testut and Poirier describe the process as sometimes being in contact with the pharyngeal wall, while Symington and others do not lay stress on this point. The writer believes that there are no cases of direct contact.

The infero-anterior part of the pharyngeal process is often marked by a deep sulcus and accordingly forms a separate lobule. This sulcus is caused by the presence of the external carotid artery which approaches posteriorly and proceeds upward and forward. The sulcus is filled by loose connective tissue. Sometimes the artery traverses the gland substance anteriorly to the process, in which case the sulcus is formed but without the lobule. Occasionally the external carotid artery is partially exposed on the surface of the gland.

THE POSTERIOR SURFACE

This is the smallest surface of the gland, excepting the superior surface. It presents an appearance which is roughly triangular or quadrangular. It is bounded superiorly by the edge formed by the junction of the superior and posterior surfaces, mesially by the pharyngeal process, and lateral by the border between this and the external surface. If a fourth border is present it is the inferior. The general form of the surface varies with the height of the pharyngeal process and the diameter of the gland. Mesially the surface shows a slight sulcus, formed by the presence of the styloid process and the muscles originating from this

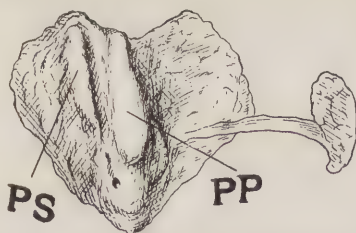


FIG. 2. *PP*, Pharyngeal process; *PS*, Poststyloid process. $\times \frac{2}{3}$, left side.

process (fig. 2). The pharyngeal process which is situated anterior to the styloid sulcus, has already been mentioned.

The post-styloid process occurs posterior to the styloid sulcus, which projects between the styloid process and the digastric muscle. As the styloid sulcus is bordered by the pharyngeal process and the post-styloid process, the sulcus is well marked if the two processes

are prominent. This sulcus varies greatly in breadth and depth, and is very seldom absent. Its course is usually straight, although it may be slightly convex.

The post-styloid process is smaller than the pharyngeal process in breadth and height. At times it is almost indistinguishable. In some cases the upper end of this process appears as a papillary-shaped, round eminence, which inserts between the mastoid and styloid processes. Parsons observed that the post-styloid ridge is more prominent than the pharyngeal process, but this appears to me to lack sufficient foundation because he studied only a few cases.

The posterior surface presents a broad area laterad to the post-styloid process. In this area two impressions may be distinguished, namely the digastric impression and the sternocleidomastoid impression. Sometimes it is possible to detect in addition the mastoid impression. These impressions are caused by the digastric and sternocleidomastoid muscles and the mastoid process respectively. The digastric impression lies mesially and the sternocleidomastoid impression laterally, while the mastoid impression is situated superior to these two. Although they are generally present sometimes these impressions are detected with difficulty because of the presence of fat tissue between or on the muscles, or because a slight longitudinal space between the bellies of the muscles. The sternocleidomastoid impression has an elongated shape corresponding to the shape of the muscle; occasionally it is very narrow and the borders—lateral and medial—are prominent so that the impression forms a sulcus (fig. 3). The digastric impression is in general flat and somewhat broader than the sternocleidomastoid impression. The gland substance between the two impressions is a longitudinal slight prominence, although now and then especially significant (fig. 3). This prominence shows a papillary process usually in the middle or superiorly, called posterior process by Testut. At times these two impressions are distinct only in their superior parts. The mastoid impression is inconstant.

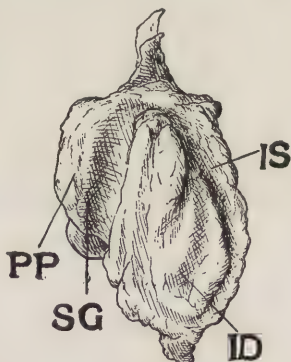


FIG. 3. IS, Sternocleidomastoid impression; ID, Digastric impression; PP, Pharyngeal process; SG, Styloid sulcus. $\times \frac{2}{3}$, right side.

THE ANTERO-MEDIAL SURFACE

This surface of the parotid covers the masseter muscle, the ramus mandibulae and the internal pterygoid muscle. The part which rests upon the masseter muscle faces mesially (medial surface), while the remainder of the surface faces anteriorly (anterior surface). There is a gradual transition from one surface to the other so that they are better considered as one. The parotid duct which arises from the medial surface will be described later. A small space is framed by the

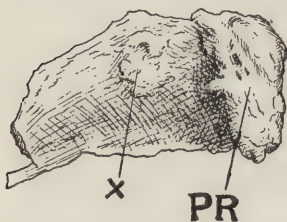


FIG. 4. PR, Retromandibular process. X $\frac{2}{3}$, right side.

ramus mandibulae, the zygomatic arch and the superficial layer of the masseter muscle. The gland substance is sometimes fixed to this space by firm connective tissue, sometimes the gland tissue itself projects into the space (X in fig. 4). Several authors describe a pterygoid process as present on this surface. Testut defines it as that part of the gland which enters the narrow space between the ramus mandibulae and the internal pterygoid muscle,

which places it laterad to the muscle. Symington puts a process of the same name mesially to the internal pterygoid muscle, while Parsons considers it the same as the pharyngeal process. The writer saw no process such as Testut and Symington describe, and it appears that Parsons' designation is a misnomer.

GLANDULA PAROTIS ACCESSORIA

The accessory parotid gland is a small group of lobules situated on the masseter muscle apart from the main portion of the gland. The majority of text books describe such separate lobules as accessory glands. Rauber-Kopsch, on the contrary, states that the accessory parotid is an anterior prolongation of the gland substance. Sappey and Poirier criticize such a designation, because the duct of the accessory gland leads into the parotid duct and not directly into the mouth. They conclude therefore the accessory gland is a part of the main gland and should not have a special name. The writer is of the opinion that, as the group of lobules is separate, it deserves an individual designation. On the other hand it is impossible for him to accept Rauber-Kopsch's definition, because the anterior process of the gland is meant thereby.

The accessory parotid gland is usually elliptic and occasionally round or irregular. It is situated for the most part along the parotid duct and is characterized by a longer horizontal than vertical diameter. Eleven cases of adult Japanese showed the horizontal diameter as 1 to 2.3 cm., averaging 1.7 cm., as compared to a vertical of 0.6 to 1.5, averaging 1.1 cm. The surface of the accessory gland is convex or flat. The lobules differ from those in the main gland in that they do not overlap.

Forty-one cases were examined (both sides of fifteen and one side in eleven Japanese heads) to determine the frequency of occurrence of the accessory gland. It was found that the accessory parotid was absent in twenty-six and present in fifteen cases. Out of the fifteen heads, six lacked the gland on both sides, seven had the gland on one side (two cases right and five left), and two had the gland on both sides. There is usually but one accessory gland on one side, but in one case there were two, one superior to the parotid duct, the other inferior to it.

The accessory glands is almost always situated just superior to the parotid duct, but in rare instances it is inferior to the duct or entirely apart from it. When it adjoins the duct it may cover the latter partially or completely, or merely be in contact with it. More seldom the reverse is the case and the duct partially covers the gland. The accessory gland varies in its relation to the main portion of the parotid gland, sometimes being close to the latter, sometimes further removed; rarely it is placed at the anterior edge of the masseter muscle. In brief the occurrence of the accessory gland in the Japanese is in the ratio of three present to five absent, in the European it was present in two out of five cases, and in the Chinese present in two out of three cases. From this no racial variation can be established. As to position, the specimens of Europeans showed two out of three cases where the accessory gland was situated at the anterior margin of the masseter muscle while for Japanese this location is rare.

DUCTUS PAROTIDEUS

If the parotid duct is viewed externally, it becomes evident that it arises at the anterior side of the parotid gland. The duct departs from the gland as a single tube, except in isolated cases where there are two ducts that unite after a short course into one. If the gland is removed so as to expose its internal surface, the parotid duct may be

traced further. (Fig. 5). By such procedure the true origin of the duct is found to be in the internal surface, although occasionally the beginning is at the anterior margin of the gland. It usually arises as a single duct, but it may originate as two ducts which unite to a common one. Many books state that the duct emerges from the anterior process or from near the anterior angle of the parotid; such cases appear to be rather the exception judging from the writer's observations. In ten specimens where the relation to the anterior process was evident, the duct arose in four instances from the apex of the process, and in six cases inferior to it. Opinions vary as to the point where the duct leaves the anterior margin of the gland: it is said to arise from the junction of the upper and middle thirds (Poirier), or



FIG. 5. PR, Retromandibular process.
 $\times \frac{2}{3}$, right side.

from the border between the middle and lower thirds (Testut). The majority of the cases here studied agree with Poirier's view. The duct, after departing from the gland, runs anteriorly on the surface of the masseter muscle, bends mesially at the margin of the muscle and opens into *cavum buccale*. Accounts of authors vary as to the course of the duct. The following variations were noticed by the writer: the duct may depart from the margin of the gland, run slightly

superiorly, then inferiorly to the margin of the muscle; or it may run straight in departing from the gland, then turn slightly inferiorly; finally, it may run straight to the margin of the muscle. In addition one case was observed in which the duct curved slightly superiorly twice, and another case where the duct inclined sharply superiorly and bent somewhat abruptly anteriorly. In the material available for comparison it was found that the parotid ducts of Europeans apparently present a more marked curve than those of the Japanese.

The parotid duct after passing the anterior margin of the masseter muscle suddenly turns antero-medio-inferiorly, except in one case where its course was medio-superior. The duct curves exactly at the margin of the muscle, but when a fat mass is present between the parotid duct and the margin of the muscle the curve is slightly removed from the margin. Perhaps it is unnecessary to state that the duct

passes through the fatty mass of the corpus adiposis buccae. At times this fat pad is well developed and extends upon the masseter muscle so as to partially or totally cover the parotid duct. In some cases there are apart from this pad isolated fat masses which may lay over the duct. Morris, Poirier and Testut estimate the length of the duct as 3.5 to 4.0 cm., Rauber-Kopsch as 5.0 to 6.0 cm., and Krause gives 6.8 cm. Vierordt says its diameter is 2 mm., others give 3 to 4 mm. The writer's results are as follows:

THE PAROTID DUCT

Japanese Infants		Japanese Adults		Japanese Adults	
Length	No. of Glands	Length	No. of Glands	Diameter in Middle	No. of Glands
2.6 cm.	2	2 cm.	1	2.5 mm.	1
2.7	1	2.5	2	3	1
2.8	1	2.6	1	3.5	2
3.0	1	3.1	1	4	8
3.1	1	3.3	2	4.5	2
3.5	1	3.4	2	5	4
3.8	1	3.5	1	5.5	2
4.0	1	3.6	1	6	1
		3.8	1		
Aver. 3.1 cm.	Tot. 9	4	2	Aver. 4.3 mm.	Tot. 21
		4.3	3		
Diameter in Middle	No. of Glands	4.4	2	Diameter	No. of Glands
2 mm.	2	4.5	1		
2.5	2	4.6	3	3 mm.	3
3	3	4.7	1	4	3
4.5	1	4.8	1	4.5	2
		4.9	1	5	7
Aver. 2.8 mm.	Tot. 8	5.1	1	5.5	1
		5.2	1	6	7
Diameter at the End	No. of Glands	5.4	1	6.5	1
3 mm.	3	6	1	7	2
3.5	1	Aver. 4 cm.	Tot. 30	9	1
4	4			Aver. 5.2 mm.	Tot. 27
6	1				
Aver. 3.8 mm.	Tot. 9				

The following measurements are given by various authorities as the distance between the parotid duct and the lower edge of the zygomatic arch: A transverse finger breadth, Morris; 1.5 to 2.0 cm., Testut; 1.5 cm. at the origin and 4 to 5 mm. at the anterior margin of the muscle, Poirier; and 1.0 cm., Rauber-Kopsch. The accompanying table shows the results obtained on the material under consideration.—

DISTANCE OF THE PAROTID DUCT FROM THE ZYGOMATIC ARCH

Japanese Infants		Japanese Adults	
Distance at Point of Departure	No. of Glands	Distance at Point of Departure	No. of Glands
5 mm.	1	1.0 cm.	2
6	1	1.1	1
10	2	1.2	1
11	1	1.4	1
12	2	1.5	1
13	1	1.7	1
14	1	1.8	2
		1.9	2
Aver. 10 mm.	Tot. 9	2.0	2
		2.1	3
Distance in Middle	No. of Glands	2.2	4
2 mm.	1	2.3	1
3	1	2.4	2
8	1	2.5	2
9	4	2.6	1
10	1	2.7	1
11	1	2.9	1
		3.6	1
Aver. 8 mm.	Tot. 9	Aver. 2.0 cm.	Tot. 29
Distance at Anterior Margin of Masseter	No. of Glands	Distance in Middle	No. of Glands
1 mm.	1	8 mm.	1
3	1	9	2
5	2	10	3
6	2	11	1
7	2	12	1
10	1	13	2
		14	1
Aver. 6 mm.	Tot. 9	15	2
		16	1
		17	1
		18	5
		19	2
		20	4
		33	1
		Aver. 16 mm.	Tot. 27
		Distance at Anterior Margin of Masseter	No. of Glands
		4 mm.	1
		5	2
		6	6
		7	1
		8	4
		9	5
		10	3
		11	1
		12	3
		13	1
		14	1
		16	1
		17	1
		Aver. 9 mm.	Tot. 30

DIRECTION OF PAROTID DUCT

Incisura ant.	to lower edge of philtrum.....	1 cases
Incisura intertragica	to lower edge of ala nasi.....	3
do	to middle of philtrum.....	2
do	to lower edge of philtrum.....	1
do	to edge of upper lip.....	1
Midway between incisura inter-		
tragica and lobulus auriculæ	to lower edge of ala nasi.....	3
do	to middle of philtrum.....	2
do	to lower edge of philtrum.....	3
do	to edge of upper lip.....	1
Lower edge of lobulus	to lower edge of ala nasi.....	13
do	to middle of philtrum.....	1
do	to lower edge of philtrum.....	3
do	to edge of upper lip.....	1
5 mm. below lobulus	to lower edge of philtrum.....	1
1 cm. below lobulus	to 1 cm. above lower edge of ala nasi.....	1
1 cm. below lobulus	to lower edge of ala nasi.....	2
2 cm. below lobulus	to lower edge of philtrum.....	1

A mention of the measurements for the Europeans and the Chinese will be omitted because there is no essential difference. (The duct lengths of the Europeans and the Chinese were not measured.)

The criteria hitherto employed to show the direction of the duct were the projections between the following points: The lobule of the ear and the wing of the nostril—Poirier; or the inferior edge of the auditory meatus and a point midway between the ala of the nose and the red of the lip—Cunningham. The writer's results are shown above.

Thus the direction of the duct in the Japanese often corresponds to the line between the point of junction of the ear lobe with the side of the head and the lower edge of the wing of the nostril. In the European the direction is more oblique. For the Chinese one case shows a more horizontal direction and two cases show obliqueness in less degree than that of Europeans.

THE PAROTID GLAND AS A WHOLE

The details concerning the various aspects of the gland having been dealt with, the gland may now be described as a whole. As already mentioned, it is divided into the external facial part, and the retro-mandibular process. The thickness of the external part is variable. The next table shows the thickness of this part at the place where it adjoins the retromandibular process.

The external part is usually thickest in the portion anterior to the retromandibular process; this is somewhat more noticeable superiorly. Peripherally to this point the gland gradually becomes thin, but the superior edge is usually somewhat thicker than the others; at other

THICKNESS OF THE EXTERNAL PART AND FRONTAL
DIAMETER OF THE PAROTID

Japanese Infants		Japanese Adults	
Thickness of External Part	No. of Glands	Thickness of External Part	No. of Glands
6 mm.	1	7 mm.	2
7	3	9	3
8	1	10	2
		11	1
Aver. 7 mm.	Tot. 5	12	2
Frontal Diameter	No. of Glands	13	3
		14	2
10 mm.	1	16	1
12	1	18	1
14	1		
19	1	Aver. 12 mm.	Tot. 17
21	1	Frontal Diameter	No. of Glands
Aver. 15 mm.	Tot. 5		
		19 mm.	1
		23	1
		24	1
		26	4
		28	3
		30	2
		31	1
		32	2
		38	1
		39	1
		Aver. 28 mm.	Tot. 17

times the gland is uniformly thick in the point anterior to the base of the retromandibular process.

The frontal diameter given in the preceding table is the distance from the external surface of the gland to the edge of the pharyngeal process. Note that it is less than either the vertical or the sagittal diameters. According to Krause the frontal diameter is 2.7 cm. The retromandibular process decreases gradually in thickness medially. The figures in the table indicate the thickness of the process as measured at its base. The height of the retromandibular process may be computed by subtracting the thickness of the external part from the frontal diameter.

The breadth and the height of the retromandibular process for Europeans average 1.6 and 2.0 cm., while for the Japanese they are 2.1 and 1.6 cm. respectively. Thus the retromandibular process of the Europeans is relatively thin and high compared to the Japanese.

The post-styloid process in the Japanese is in the ratio of one present to three absent; while in the Europeans there were two absent

MEASUREMENTS OF THE RETROMASTOID PROCESS
OF THE PAROTID

Japanese Infants		Japanese Adults	
Breadth of Proc. Retrom.	No. of Glands	Breadth of Proc. Retrom.	No. of Glands
10 mm.	1	15 mm.	1
14	1	17	1
16	1	18	1
18	2	19	2
		20	1
Aver. 15 mm.	Tot. 5	21	5
Height of Proc. Retrom.	No. of Glands	22	2
3 mm.	1	23	3
5	1	26	1
7	1	28	1
11	1		
14	1	Aver. 21 mm.	Tot. 17
Aver. 8 mm.	Tot. 5	Height of Proc. Retrom.	No. of Glands
		9 mm.	1
		10	1
		12	1
		13	2
		14	2
		15	1
		16	3
		17	1
		21	1
		22	1
		24	1
		27	1
		30	1
		Aver. 16 mm.	Tot. 17

out of five cases. In the Europeans the absence was more definite than in the Japanese, naturally the styloid sulcus being also absent. The pharyngeal process is narrow and high in Europeans, which was especially obvious in two cases (fig. 6). There is no such difference in comparing the Chinese to the Japanese.

Since the parotid gland is easily moulded by its surroundings, a part such as the retromandibular process will be influenced in its shape by the enclosing walls; and if those factors which influence the form of the retromandibular process are taken into consideration, it will be seen that the final shape of the gland will vary with the position of the head at the time of fixation. Therefore a minor difference in the pharyngeal process of the gland found by comparing the Japanese with the European might possibly be considered an artifact. But the appearance in several cases of European specimens was so markedly different that their causation by artificial means did not appear possible.

In addition to those already brought out, there are differences in the divergence between the ratio of diameters of the outer surface of the parotid of the adult as compared to the fetus. In the fetus the cavity containing the parotid gland is filled with fat anteriorly and posteriorly to the styloid process, and also there is often a plentiful amount of fat along the blood vessels, so that the pharyngeal process, styloid sulcus, and post-styloid process are often poorly marked. The retromandibular process is also not as distinct as in the adult. The anterior surface of this process undergoes an almost imperceptible transition to the internal surface. The impressions in the posterior surface are generally not deep.

The parotid assumed abnormal shapes in several cases. In one instance the external part was long transversely, with the vertical diameter and the retromandibular process relatively small. The diminution in the size of the retromandibular process was not because of the decrease of size of its recess, but was caused by the presence of fat and connective tissue. The breadth of the retromandibular process was less than one-third of its sagittal diameter. The case pictured in figure 5 shows retromandibular process that is exceedingly thick and large compared to the external part. In a case mentioned



FIG. 6. PP, Pharyngeal process.
× $\frac{3}{8}$, left side.

before the external part of the gland was large, covered the greater part of the masseter muscle, extended anteriorly along the mandibula, and united firmly with the submaxillary gland, allowing no separation from the latter. Finally in one case, the anterior process and the other external part each assumed a triangular shape so that their bases were directed toward the ear, their apices pointing anteriorly and inferiorly respectively.

THE PAROTID GLAND OF THE APES

The comparative anatomy of the parotid gland of the ape was studied by Huntington, but the observations were restricted to its external surface, and the comparison of the gland in the ape with that in the human subject was not emphasized. The writer has studied

the parotid in the Japanese macaque and observed the following differences from the human forms.

In the human parotid gland the posterior part of the external surface is at times firmly united with an aponeurosis, in the macaque the aponeurosis unites uniformly with the external surface. For the ape the dimensions of the gland are: average volume, 7 c.c.; sagittal diameter, 2.9 to 4.7 cm., averaging 3.9 cm.; and vertical diameter 2.4 to 4.3, averaging 3.6 cm. From this it is seen that the size of the external surface of the gland in the macaque is relatively large.

The primary lobules in the ape overlap but do not appear so distinct as in man, having only scanty connective tissue between them. Also the size of the lobules is smaller than in man. The external surface of the ape gland seems flat, although one case out of four showed a convex surface. The lower angle is always easily distinguishable. The anterior angle is also marked, and is situated inferiorly to the inferior edge of the zygomatic arch. The superior border of the macaque gland runs either along the inferior edge of the zygomatic arch or across the arch. The posterior angle is constantly more inferior than the preauricular process in man, but situated at the same level in this ape.

The superior surface of the macaque parotid is narrow. A distinct sulcus descends medio-inferiorly. In man this sulcus extends over the styloid sulcus, while in the macaque it runs along the inferior surface of pars tympanica and pars petrosa in an antero-medial course (fig. 7). One case in four in the ape showed the formation of the styloid sulcus. The pharyngeal process was always present. The shape of the posterior surface is triangular, the apex being directed superiorly. The impressions are not well marked, but this might be due to alcohol fixation. The angle between the anterior and medial surfaces is well defined. The measurements are as follows: Thickness

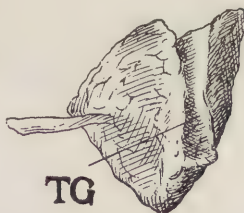


FIG. 7. TG, Sulcus formed along the lower surface of the temporal bone. $\times \frac{2}{3}$, right side.

of the external part, average 7 mm.; frontal diameter, average 18 cm., and average breadth and height of the retromandibular process, 1.2 cm. and 1.1 cm. Thus the retromandibular process is narrow and the external part thin as compared with that in the human parotid. The presence of the accessory gland could not be detected in the monkey. Huntington reports the absence of the accessory gland also

in *Macacus cynomolgus* and *Macacus nemestrinus*. The parotid duct arose in most instances from the superior part of the anterior process which differs from its origin in man. In the human subject the duct presents a curvature, in the macaque it is straight until it reaches the anterior edge of the masseter muscle; here, in man, the duct turns suddenly medio-inferiorly while in the macaque it gradually proceeds mesially. The zygomatic arch and the parotid duct tend to converge anteriorly in the human being, in macacus they run parallel, sometimes several millimeters apart and sometimes close together. The length of the parotid duct in the ape varies from 1.4 to 2.7 cm. averaging 2.1 cm., and its thickness is 2 to 4 mm., averaging 3 mm. The direction of the duct is not directly comparable to man. It corresponds to a line drawn between the ear lobule or the incisura intertragica and a point in the vicinity of the angle of the mouth.

CONCLUSIONS

The results of the present study appear to show that: There is no appreciable difference in the volume of the parotid in the Japanese and the Europeans, and no marked difference was noticed in its general form; but some racial differences are indicated in the sagittal diameter of the gland, in its anterior process, in the connective tissue between the gland and the sternocleidomastoid muscle, in the processus retromandibularis, processus post-styloideus, and processus pharyngeus. There are signs that much more marked differences exist between the parotid of man and that of at least some other primates. All of this calls for further observations.

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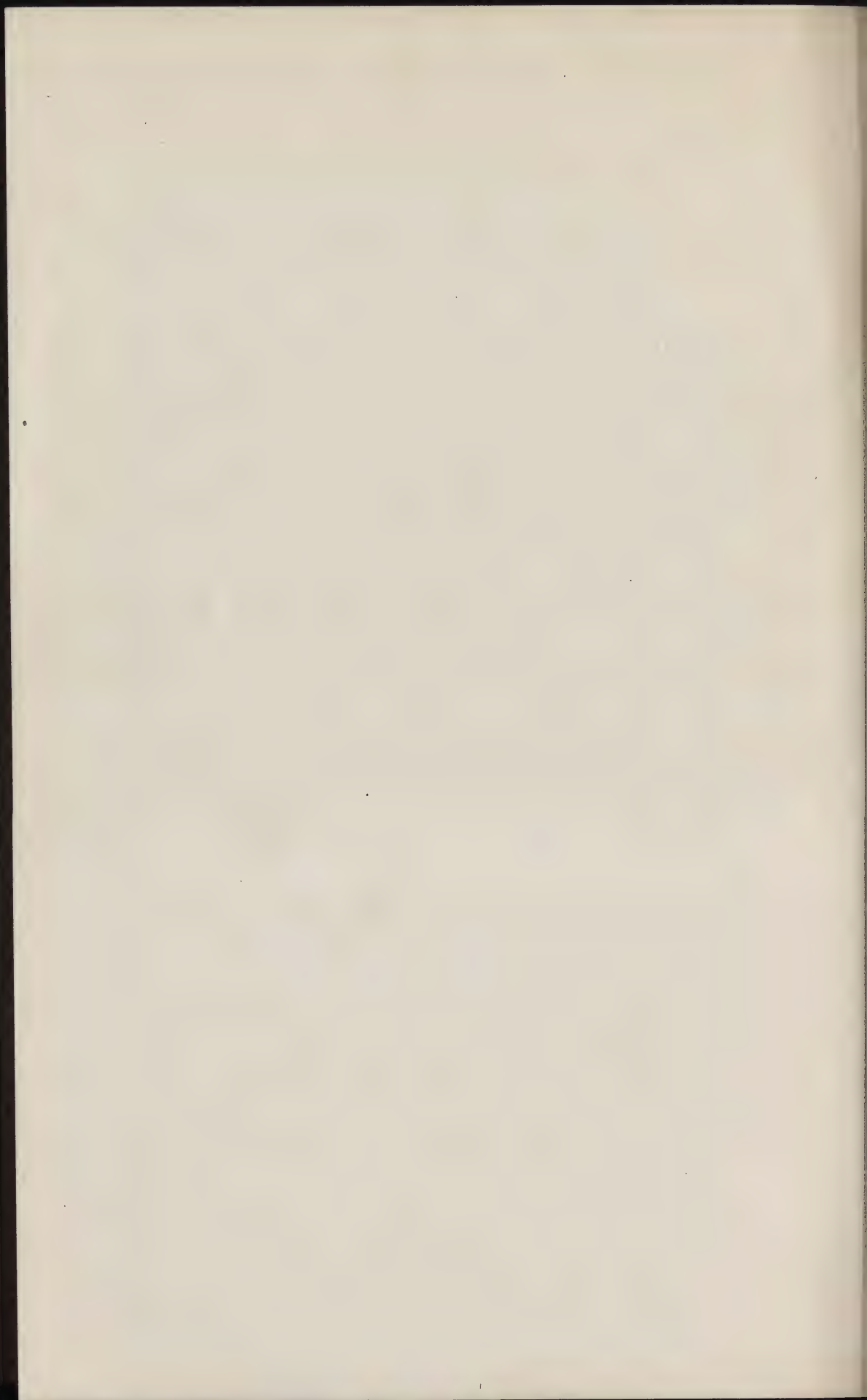
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DETAILED TABLE OF MEASUREMENTS OF PAROTID GLANDS OF JAPANESE

		No. of Cadaver	Age	Side	Size, Cc.	Sagittal Diameter, Cm.	Vertical Diameter, Cm.	Frontal Diameter, Cm.	Thickness of External Part, Cm.	Retromandibular Process		Length of Parotid Duct, Cm.	Diameter of Parotid Ducts		Distance Between Parotid Duct and Zygomatic Arc			Processus Anterior	Gl. Parotids Access.		
										Height, Cm.	Breadth, Cm.		Middle, Mm.	End, Mm.	Point of Departure, Cm.	Middle, Cm.	Anterior Edge of M. Mas., Mm.				
Infants	Male	1776.	3 mo.	r.	5	3.1	2.4	1.0	.7	.3	1.0?	2.6	2	3.5	.5	.3	3	+	+	-	
		1787.	3 yr.	r.		2.9	2.5					2.6		3	.6	.2	1	+	+	++	
	Female	4152.	2	r.	5	3.1	3.0	2.9	1.2	.7	.5	1.4?	3.5	3	4	1.2	.9	7		+	-
		2358.	6	r.		3.7	3.9	3.9	2.1	.7	1.4	1.8	4.0	4.5	6	1.4	.9	6	-	+	-
		4233.	7	r.	5	4.2	2.8	1.4	.6	.8	.8	1.8	2.8	3	4	1.3	1.1	10	+	+	-
		2356.	8	r.	8	4.0	3.2				.8	1.1	1.6	3.1	2	4	1.1	.9	7	+	+
			r.		4.3	3.2	1.9					2.7	2.5	3	1.0	.9	5	+	+	-	
						4.0	3.4					3.0	2.5	3	3	1.0	.8	5	+	+	-
Adults	Minimum				5	2.9	2.4	1.0	.6	.3	1.0	2.6	2	3	.5	.2	1	+7	+3		
	Maximum				15	4.4	3.9	2.1	.8	1.4	1.8	4.0	4.5	6	1.4	1.1	10	-1	-7		
	Average				8	3.7	3.1	1.5	.7	.8	1.5	3.1	2.8	3.8	1.0	.8	6	Tot. 8	Tot. 10		
	3887.	15	r.	10	5.1	4.6	2.3	.7	.7	1.6	2.1	2.5	2.5	6	1.0	.8	6	+	+	+	
	2243.	22	r.	10	5.3	3.0	1.9	1.0	1.0	.9	1.5	2.6	3	3	1.0	.9	9	+	+	+	
	4264.	23	r.	15	5.7	3.8						2.0	3	3	3.4		5	+	+	+	
	3388.	23	r.	15	4.6	6.0	2.4	1.4		1.0	2.3	5.4	5.5	6.5	3.6	3.3	9	-	-	-	
	3334.	25	r.	15	4.0	4.2						4.9	4	3	1.5	1.0	7	-	+	+	
4268.	25	r.	14	4.6	4.0	3.0			.9	2.1	1.7	4.3	3.5	5.5	2.2	1.8	8	+	+	+	
					7.2	6.3						6.0	4	6	2.1	1.0	5	+	+	+	
					5.3	5.3						3.1	4	6	2.2	1.8	8	+	+	+	
					5.0	4.7						4.3	3.5	5.5	1.4	.9	11	+	+	+	

DETAILED TABLE OF MEASUREMENTS OF PAROTID GLANDS OF JAPANESE—Continued

	No. of Cadaver	Age	Side	Size, C.c.	Sagittal Diamete- ter, Cm.	Vertical Diamete- ter, Cm.	Frontal Diamete- ter, Cm.	Thickness of Ex- ternal Part, Cm.	Retromandibu- lar Process		Length of Parotid Duct, Cm.	Diameter of Parotid Ducts		Distance Between Parotid Duct and Zygomatic Arc			Processus Anterior	Gl. Parotis Access.
									Height, Cm.	Breadth, Cm.		Middle, Mm.	End, Mm.	Point of Depart- ure, Cm.	Middle, Cm.	Anterior Edge of M. Mas., Mm.		
Male	4286.	29	l.	23	5.0	5.2	2.8	1.3	1.5	2.0	4.5	4	5	2.1	1.8	8	+	+
	2299.	46	r.	30	5.1	5.1	3.2	1.6	1.6	2.1	4.6	4	4.5	2.6	1.9	6	+	?
	4145.	48	l.	33	5.1	5.4	3.8	1.1	2.7	2.8	4.8	4	5	2.4	1.3	8	-	+
	3541.	49	l.	26	5.0	6.0	3.8	1.3	1.3	2.6	4.6	5	7	2.7	1.1	6	-	+
	2860.	52	r.		4.6	5.6	2.6	1.3	1.3	2.6	4.4	5.5	9	2.9	1.8	10	-	-
	4242.	54	l.		5.8	6.5	2.6	1.3	1.3	2.6	3.4	3.5	5	2.0	1.2	9	+	-
	3544.	64	l.	13	6.5	9.4	2.6	1.3	1.3	1.9	3.3	6	6	1.8	1.5	9	+	+
			l.		7.0	7.0	2.6	1.3	1.3	1.9	4.3	4	4?	2.5	2.0	12	+	?
			l.			5.4	3.2	1.0	2.2	2.2	4.4	5	6	1.9	1.7	13	-	+
			r.		20	6.0	6.5	3.9	.9	3.0	2.2	3.8	5	5	1.7	1.2	12	+
Female	4275.	19	l.	20	9.0	4.0	2.8	1.2	1.6	2.1	3.3	3	4	2.2	1.9	12	+	+
	4207.	22	l.	13	4.0	4.7	2.6	.9	1.7	1.9	3.4		5	2.3	2.0	17	+	-
	4258.	25	l.	20	4.0	4.5	2.6	1.2	1.4	2.1	4.0	4	4.5	2.0	1.8	10	-	+
	4257.	30	l.	20	4.5	4.6	2.6	1.8	1.2	1.8	4.6	4		2.4	2.0	16	+	+
	3886.	33	l.	18	4.2	4.8	3.0	1.8	1.2	1.8		4		2.2	2.0	14	-	+
	4161.	56	l.	25	5.0	4.5	2.8	1.4	1.4	2.3	4.3		6	1.8	1.6	10	-	+
			r.	18	5.0	6.0	3.1	.7	2.4	2.1	3.6	4.5	5	2.1	1.5	6	-	+
			l.	19	5.7	5.3	3.1	1.7	2.4	2.1	2.5		5	1.1	1.1	6	+	-
	Minimum	.....		10	3.9	3.0	1.9	.7	.9	1.5	2.0	2.5	3	1.0	.8	4	+17	+14
	Maximum	.....		33	9.0	9.4	3.9	1.8	3.0	2.8	6.0	6	9	3.6	3.3	17	-13	-16
Average	.....		19	5.2	5.3	2.8	1.2	1.7	2.1	4.0	4.3	5.2	2.1	1.6	9	Tot. 30	Tot. 30	



SHOVEL-SHAPED TEETH

ALEŠ HRDLIČKA

I. LITERATURE

Since the beginning of his work on Indian crania and on the teeth of the living Indian, the writer has noticed that the upper incisors in this race have generally a characteristic form, differing from that of most whites and negroes. Later he observed that the same form occurred frequently in various other yellow-brown peoples, such as Malays, Mongolians, Chinese and Japanese, but was less common to rare in other racial groups. He repeatedly called attention to the feature in publications relating to the Indians, but the notes were rather casual, and they appeared in general accounts and reports on crania where they remained submerged.

The character in question consists of a peculiar, pronounced hollow of the lingual surface of the teeth, bounded laterally or surrounded by a well-defined elevated enamel border. Such teeth resemble more or less an ordinary coal shovel, in consequence of which they were termed 'shovel-shaped' incisors.

The notes thus far published on these teeth by the author are as follows:

1907.—*The teeth of the Indian "are of moderate size; upper incisors are ventrally concave, shovel-shaped; canines not excessive; molars much as in whites; third molars rarely absent when adult life is reached."* (Art. "Anatomy," Handb. Amer. Ind., Bull. 30, B.A.E., 55).

1908.—*"In the Indians the upper incisors of the second dentition are ventrally deeply concave and shovel-like, differing in this respect from the form usually found in whites. With this character (thus far apparently ignored) it is occasionally found that the median point ventrally on one or both the lateral (very rarely median) incisors develops into a cusp, which when more pronounced gives the tooth nearly the appearance of a bicuspid. ("Physiological and Medical Observations among the Indians of the S. W. United States and Northern Mexico," Bull. 34, B.A.E., 124.)*

1908.—“The upper incisors, where preserved, show the pronounced ventral concavity, or shovel form, which is encountered in nearly all of the Indians.” (“Report on a Collection of Crania from Arkansas,” *J. Ac. Nat. Sc. Phila.*, XIII, 562.)

1909.—“The *upper incisors*, when present and well preserved, show generally the shovel-like, sharply outlined ventral concavity so characteristic of these teeth in the Indians and to which attention has hitherto been called by the writer.” (“Rep. on Additional Collection of Skeletal Material from Arkansas & Louisiana,” *J. Ac. Nat. Sc. Phila.*, XIV, 209.)

1910.—“The upper incisors are seen, in all cases where they have not been too far worn down, to have a peculiar shovel-shaped ventral appearance common to the Eskimo and the Indians.” (Contribution to the Anthropology of the Central and Smith Sound Eskimo, *Anthrop. Papers, Am. Mus. Nat. Hist.*, V, Pt. 2, 261, 266.)

1911.—“The type of human denture can be said to be to-day, with a few exceptions, radically everywhere the same. About the greatest of these exceptions concerns the form of the upper permanent incisors, which in one respect are substantially different in the Indians from what they are in the whites, negroes and at least some other races. The upper and particularly median upper permanent incisors of the Indian are peculiarly and pronouncedly concave on the buccal surface. I call these teeth shovel-shaped. The condition is seen with especial clearness before the teeth have suffered any wear. I have called attention to this feature in a number of my publications. It is due to an extraordinary development of the lateral borders of the ventral surface of the crown. Sometimes these borders are so developed that they appear as if folded over the sides of the lingual surface of the tooth. They converge upwards, and at the point of convergence there is often seen a more or less rudimentary cusp. At the same time the dorsal surface of the crown of these teeth is frequently more convex from above downwards than in the whites. This form of an incisor is found only seldom in the white, and, on the other hand, is but very seldom wanting in the Indian. Generally all the four upper incisors will be thus marked, but occasionally the condition is limited to the median incisors.” (“Human Dentition and Teeth from Evolutionary and Racial Standpoint,” *Dominion Dent. J.*, 1911, 412-413.)

1912.—The teeth of the Indian are “of medium size when compared with those of mankind in general, but perceptibly larger when contrasted with those of the white American; and the upper incisors are

characteristically shovel-shaped, that is, deeply and peculiarly concave on the buccal¹ side." ("Problems of the Unity or Plurality and the Probable Place of the American Aborigines," *Am. Anthropol.*, XIV, 10.)

1916.—"The upper incisors [of the Lenape], especially the middle, are shovel-shaped lingually, as usual in Indians." ("Physical Anthropology of the Lenape or Delawares, and of the Eastern Indians in General," *Bull.* 62, B.A.E., 52.)

1917.—"The teeth [of the Indian] are of medium size when compared with those of primitive man in general, but frequently are perceptibly larger when contrasted with those of the cultured white American or European; the upper incisors of the Indian present throughout, with rare individual exceptions, an especially important feature; they are on the inside, or lingually, characteristically shovel-shaped, that is, deeply and peculiarly concave, with a marked cingulum."² ("The Genesis of the American Indian," *Proc.* XIX, Int. Cong. Amer., 561).

1918.—"The crown [of a left upper median incisor of the supposedly ancient skeleton No. 2 from Vero, Fla.] is worn down to about one half its original size, so it is difficult to determine the original form of its lingual surface, but it is seen that this was somewhat concave or shovel-shaped, as in Indians, though the concavity was probably less pronounced than in most members of the race. There are however, full-blood Indians in whom this concavity is slight and in rare cases it is entirely absent."

During 1919, and particularly in the course of the present year, some long wished-for opportunities arose which enabled me to take up the question of racial differences in the incisors more in earnest and to extend it to a number of other features besides the shovel-shaped character. I was encountering in the finer modelling of the front teeth a number of usually neglected marks, which though mostly inconspicuous and not seldom wholly absent, recurred again and again in the same form and place, and therefore could not be without significance. This led inevitably also to an examination of considerable odontological and anatomical literature for possible notes of other students on these conditions, and the search brought to light that the occurrence of one or another of these forms has, though sparsely, and inadequately been noted by other observers.

It is difficult to determine whom to credit with the first mention of

¹ *I.e.*, lingual.

² Should read "enamel rim or border."

"shovel-shaped" incisors. The occasional existence of a more or less deeply hollowed out lingual surface of the upper incisors, bounded on each side by an elevated lateral border, is noted here and there since at least the beginnings of the latter half of the last century, in writers such as Carabelli, Tomes, Mühlreiter, Zuckerkandl, Black and Wortman. It receives somewhat closer attention in the more recent publications of Wahlkoff, Adloff, de Terra, Bolk, Birmingham and others, but without anywhere being made the subject of a special study. The principal references to the feature read as follows:

CARABELLI:¹—Fig. 4, Pl. XIV, of his Atlas, pictures casually a shovel-shaped median incisor and also a somewhat similar lateral incisor, his explanatory text reading: "On the inner surface of the left median upper incisor is visible a large and deep hollow."²

A much more definite reference is found, in 1870, in Mühlreiter:³—*Upper Incisors*:—"Their crown resembles in general a chisel or a shovel . . . *Median Upper Incisors*: The lingual surface of the crown is strongly hollowed out, appears somewhat triangular and ends on the root in a dull flat swelling, formed seemingly by a somewhat greater enamel deposit at that place." To which is added in the third edition, 1912:⁴ "When comparing the median surface of a large number of median upper incisors, it will be observed that the lateral borders are almost regularly slightly swollen, and fuse with the tuberosity. As a result the lingual surface appears bounded by two lateral ridges (*limbus dentis*), and in case of a stronger development

¹ Carabelli (G.)—Systematisches Handbuch der Zahnheilkunde. 2 vols. & Atlas, 8°, Wien, 1844.

² "An der inneren Fläche der linken mittleren grossen Schneidezähnes ist eine bedeutend grosse und tiefe Aushöhlung zu sehen" (similar note about the upper lateral incisor; no effort at explanation).

³ Mühlreiter (E.)—Anatomie des menschlichen Gebisses. 1st ed., Leipzig, 1870, 10–15. His casual use of the term 'shovel' was not known to the writer till recently:

"*Schneidezähne*. Die Krone derselben gleicht im allgemeinen einem Meissel oder einer Schaufel . . . *Obere mittlere Schneidezähne*. Die Zungenfläche ist stark ausgehöhlt, erscheint etwas dreieckig und endet an der Wurzel mit einem sehr stumpfen, flachen, von einer anscheinend etwas stärkeren Schmelzlage gebildeten Höcker."

⁴ "Bei der Vergleichung einer grossen Anzahl von oberen Zentralschneidezähnen bemerkt man zunächst, dass die Seitenränder (mesiale und distale Kante) fast regelmässig ein klein wenig aufgewulstet sind und mit dem Tuberculum verschmelzen. Dadurch erscheint die Zungenfläche von zwei Randleisten (*Limbus dentis*) eingesäumt und bei stärkerer Aufwulstung derselben auch der Breite nach tief ausgehöhlt. Ich finde, dass es verhältnismässig doch selten ist, wenn diese Randleisten ganz fehlen, und wenn die Zungenfläche überhaupt ohne alle Modellierung von dem abgeflachten Tuberkulum plan oder mässig gewölbt gegen die Schneide hin absteigt."

of the latter looks also deeply hollowed out from side to side. I find that it is rather seldom that these lateral borders are completely absent. . . ."¹

"*Lateral upper incisors*:²—They have in general nearly the same form and characteristics as the median. . . . On the lingual surface we may observe a feature, often but indicated in the median incisors, consisting of an enlargement of the lateral borders to marked ridges, which unite in the rounded eminence with which the lingual surface terminates on the root. Due to these elevated borders the lingual surface which they bind appears more deeply hollowed out." Which in the third edition is replaced by the following: "*Lateral Upper Incisors*. These have in general nearly the same outline and the same characteristics as the medians . . . Not very seldom we find a lingual surface which shows almost no hollowing out. Much oftener however the lateral borders will be strongly pronounced, while the intervening part of the lingual surface remains without special modelling and appears merely considerably deepened. The lateral borders themselves pass into the tuberosity either without any mark of separation or the two will be separated by a shorter or a longer groove."

TOMES:³—*Upper Median Incisors*—The lingual surface "is nearly flat from side to side with a slight tendency to concavity, while from above downwards it is distinctly concave, and often presents longitudinal depressions similar to those on the labial surface. The lingual surface towards the gum terminates in a distinct prominence,

¹ 1st ed.—"*Obere seitliche Schneidezähne*. Sie haben fast die nämlichen Umriss und die gleichen Merkmale an sich wie die mittleren . . . Endlich bemerkt man an der Zungenfläche, während bei den vorhergehenden Zähnen das folgende Merkmal nur manchmal angedeutet zu finden ist, dass die beiden Seitenkanten förmliche Wülste bilden, die sich in der abgerundeten, stumpfen Hervorragung vereinigen, mit welcher die Zungenfläche an der Wurzel endet. Durch diese die Zungenfläche einfassenden Wülste erscheint sie selbst tiefer ausgehöhlt."

² "*Obere seitliche Schneidezähne*. Sie haben fast die nämlichen Umriss und die gleichen Merkmale an sich wie die mittlere. Eine fast gar nicht ausgehöhlte Zungenfläche . . . kommt verhältnismässig nicht selten vor. Viel öfter aber werden die Randleisten besonders kräftig hervorgewölbt, während der dazwischen liegende Teil der Zungenfläche ohne eigentliche Modellierung bleibt und nur stark vertieft erscheint. Die Randleisten selbst gehen hierbei am Tuberkulum entweder ohne Unterbrechung inaneinander über, oder sie werden durch eine kürzere oder längere Spalte getrennt."

³ Tomes (Ch. S.)—*A Manual of Dental Anatomy, Human and Comparative*. 12mo, Lond., 1st ed. 1876; quoted after 2d and 6th Engl. ed., but substantially the same as in the 1st ed. (pp. 8–10).

oftentimes amounting to a bounding ring of enamel, termed the *basal ridge*, or, in the language of comparative anatomy, the *cingulum*. It is variable in the extent of its development; it rarely rises into a central prominence at the back, but in the angle where the ridges of the two sides meet a deep pit is sometimes left in the enamel, though this must be regarded as a departure from the normal. . . .” *Lateral Incisors*: On the lingual surface, “the enamel terminates towards the gum in contours precisely similar to those which obtain in the centrals, but the basal ridge, or *cingulum*, is often more strongly pronounced, and the presence of a central tubercle upon it is less infrequent.”

ZUCKERKANDL:¹—“The *Median Upper Incisors*. . . . The *labial surface* forms an oblong quadrilateral with almost parallel sides, the vertical lines of which are longer than the transverse. . . . The surface is both from side to side as well as from below upwards slightly convex, the lateral convexity predominates, the opposite condition being noted only exceptionally.”

¹ Zuckerkandl (E.)—Makroskopische Anatomie der Mundhöhle mit besonderer Berücksichtigung der Zähne, in Scheff's Handb. d. Zahnheilk., Wien, 1 ed. 1880, 2 ed. 1902; also 8° Wien, 1891. Quoted after the separate publication which shows traces of revision absent in Scheff's book.

“Die *Lippenfläche* bildet ein längliches, mit fast parallelen Seitenkanten versehenes Viereck, dessen senkrecht gestellte Seiten länger sind als die horizontalen. . . . Die Lippenfläche ist überdies sowohl nach der Breite, wie nach der Höhe leicht gewölbt, die Querkwölbung überwiegt, und nur ausnahmsweise trifft das Gegentheil zu.”

“Die Zungenfläche ist schmaler als die Lippenfläche, in der Richtung vom Hals gegen die Schneide stark ausgehöhlt, von einer zur anderen Seite hingegen mehr flach. . . . Die Aushöhlung der lingualen Fläche wird an der Peripherie von einer leistenartigen Seitenkante (*Crista dentalis*—in Scheff *Limbus dentis*) umsäumt, welche am Halse, wo sich eine stärkere Schmelzschicht ablagert, zu einem stumpfen Höcker (*Tuberculum dentale*) anschwillt. Die Tiefe der Aushöhlung, die Dicke des leistenartigen Randes und die Grösse des *Tuberculum dentale* sind hinsichtlich ihres Entwicklungsgrades mannigfachen Verschiedenheiten unterworfen, woraus eine Reihe von Formen resultiert, die eine nähere Betrachtung verdienen:

(a) Die linguale Zahnfläche ist vom schmalen Saume abgesehen bloss ganz leicht vertieft, und an derselben finden sich drei Furchen von welchen zwei unmittelbar unterhalb des *Tuberculum* beginnen. Die Furchen endigen oberhalb der Schneide und geben Veranlassung zur Bildung von mehreren Längswülsten.

(b) Von *Tuberculum* gehen ein bis zwei Wülste aus, die allmählich sich verflachend an der Zungenfläche verschwinden.

(c) Die *Crista* und das *Tuberculum* sind breit und stark vorspringend, die Aushöhlung an der Zungenfläche auffallend entwickelt und es kommt dabei vor, dass die Aushöhlung das *Tuberculum* unterminiert, zumal wenn letzteres nach unten sich stark verlängert.

"The lingual surface is narrower than the labial. It is strongly concave in the direction from the neck towards the cutting edge but is more flat from side to side. . . . On its periphery the concavity of the lingual surface is bounded by an elevated border (*Crista dentalis*) which on the neck, where there is a stronger enamel deposit, enlarges to a dull tuberosity (*Tuberculum dentale*). The depth of the concavity, thickness of the rim and size of the tuberosity, are subject to many variations which give rise to a series of forms that deserve a closer attention:

"(a) The lingual surface, without taking account of a slight border, is but slightly concave and shows three grooves of which two begin immediately below the tuberosity, end on the cutting edge and give rise to the formation of several vertical ridges.

"(b) From the tuberosity proceed one to two ridges which, gradually diminishing in prominence, disappear on the lingual surface.

"(c) The *Crista* (*Limbus* in Scheff) and the tuberosity are broad and prominent, the hollow of the lingual surface strikingly developed. It even happens that the hollow undermines the tuberosity, especially when the latter shows a strong projection downwards.

"(d) In the angle where the lateral borders unite to form the tuberosity there exists a little fissure.

"(e) The tuberosity is prolonged, gradually flattening up to the cutting edge of the tooth. Between the ridge thus formed and the elevated lateral border on each side is formed a small depression.

(d) In dem Winkel, wo die seitlichen Cristae zum Höcker sich vereinigen, bleibt ein Grübchen zurück.

(e) Das *Tuberculum* verlängert sich, dabei allmählich flacher werdend, bis gegen die Schneide hin. Zwischen dem verlängerten Wulste und dem aufgeworfenen seitlichen Rande etabliert sich je ein Grübchen.

(f) Das *Tuberculum* ist durch eine tiefe Furche, beziehungsweise durch ein Grübchen in zwei gleiche oder ungleiche Hälften getheilt, die jederseits in die *Crista* sich fortsetzen.

(g) Endlich führe ich noch an, dass nicht selten die Zungenfläche beinahe gar keine Modellierung besitzt, sondern von dem diesfalls abgeflachten *Tuberculum* gegen die Schneide als plane Fläche absteigt" . . .

"*Obere seitliche Schneidezähne.* Die oberen seitlichen Schneidezähne sind kleiner als die mittleren, zeigen aber sonst die gleichen Umrisse und eine ganz ähnliche Modellierung . . .

"An der *Zungenfläche* sind die Hälften des *Limbus dentis* häufiger als an den mittleren Schneidezähnen zu dicken Wülsten umgeformt; sie vereinigen sich am oberen Kronenrande in der bereits angegebenen Weise zu einem *Tuberculum dentale*. Durch die periphere Wülstung wird die Concavität der Zungenfläche noch tiefer, häufig sogar in ein förmliches Grübchen (*Foveola dentis*) umgewandelt."

"(f) The tuberosity is divided by a deep to slight fissure into two equal or unequal halves which pass on each side into the elevated lateral border.

"(g) Finally I want to add that not seldom the lingual surface shows almost no modelling, but proceeds from in this case flattened tuberosity towards the cutting edge as a plain surface. . . ."

"*The upper lateral incisors.* The upper lateral incisors are smaller than the median, but aside from this they show the same form and very much the same modelling. . . .

"On the *lingual surface*, the lateral borders are more frequently than on the median incisors transformed into thick ridges, which unite on the upper part of the crown in the already described manner to a dull elevation (*Tuberculum dentale*). Through the peripheral ridges the concavity of the lingual surface will be considerably deepened and frequently even changed into a regular pit (*Foveola dentis*)."

WORTMAN:¹—*Median upper incisors* (p. 440)—"The interior or palatine surface is also triangular, but the base is formed by the free cutting edge and the apex turned toward the root. Usually, this surface is nearly flat, but in some examples it presents a broad central concavity, whose depth may be considerably augmented by the presence of two marginal ridges meeting at the radicular extremity or apex of the triangle. These ridges, which are homologous with the cingulum of other teeth, sometimes develop a small cusp at their point of junction, in front of which there is usually a deep pit in the enamel. . . . As a general rule, the cingulum is but faintly marked and the posterior or palatine face is slightly concave.

The *lateral incisors* of the upper jaw are smaller than the median pair, but have approximately the same form. The labial face is more convex from side to side and the outer or distal angle of the cutting edge is much more rounded off than in the median. The lingual surface may be slightly concave from above downward, and convex in the opposite direction, without any trace of the cingulum, or, as is most generally the case, it is concave with the cingulum present, and elevated into a small cusp at the point of junction of the two lateral ridges. . . ."

BLACK:²—*Median upper incisors*:—"The lingual surface of the crown is concave in all directions, forming a *fossa*, bounded by the

¹ Wortman (J.)—*Comparative Anatomy of the Teeth of Vertebrata*. The Am. Syst. of Dentistry, 1886, I, 351–515; also separ.

² Black (G. V.)—*Descriptive Anatomy of the Human Teeth*. 1st ed., Phila., abt. 1889; quoted after 3d and 4th eds., 1894, 1897.

cutting edge, the mesial and distal marginal ridges, and the linguo-gingival ridge, or cingulum. The marginal ridges are strong elevations of the enamel running from the mesio-incisal and disto-incisal angles along the borders of this surface to near the gingival line, where they join the linguo-gingival ridge. The *linguo-gingival ridge* is a strong elevation of the enamel forming the linguo-gingival border of the crown. It is sometimes elevated into a tubercle. The lingual fossa is usually smooth, and the ridges by which it is bounded are not prominent. In many instances, however, there is a deep pit at the junction of the linguo-gingival ridge with the lingual surface proper; and in some a groove extends from the pit for a short distance along the border of each marginal ridge. . . . "

The lingual surface of *lateral upper incisors* "is very irregular in the extent of its concavity. Some are almost flat, while others are deeply concave. The mesial and distal marginal ridges are proportionately broader and stronger than in the centrals. . . . Generally, the lingual surface is almost smooth, but in many a pit, with or without lateral fissures, will be found at the junction of the lingual surface proper, with the linguo-gingival ridge. In some of these, the linguo-gingival ridge is unusually short, so that the marginal ridges are folded in together at their gingival ends, forming a deep sulcus between them, and there is a deep pit at their junction."

The more recent writers on teeth follow as a rule one of those here quoted, mostly Tomes or Zuckerkandl, and the extent of knowledge regarding the condition in question is perhaps best shown by Birmingham's concise statement in Cunningham's Text Book of Anatomy,¹ which reads as follows:

"The posterior concave surface of the crown in the upper incisors is usually limited towards the gum by a Λ -shaped ridge, known as the *basal ridge* or *cingulum*. The two limbs of the Λ are continued up along the sides of the posterior surface, whilst the apex is turned towards the gum; and here, particularly in the lateral incisor, there is often developed a small *lingual cusp*. The cingulum is rarely found on the lower incisors."

The possibility that the shovel-shaped characteristic of the upper incisors may have a racial and perhaps even phylogenetic importance, has not so far been considered. The total knowledge of the distribution of the condition outside of the American Indian seems to be restricted to two rather casual and regrettably erroneous reports, one

¹ 3d ed., 1909, 1017.

by Arkövy and one by Schwerz. Arkövy, in 1904,¹ in examining the human crania of the Anthropological Institute at Budapest for certain marks of "reduction" on the teeth, was struck by the fact that not merely could "the lingual surface of the upper lateral incisors [no mention, strangely, is made of the median teeth] be observed only here and there to show a developed cingulum, but that instead there would exist a tuberosity."² He associates the 'foveola' or central concavity of shovel-shaped incisors with the so-called 'foramen caecum' of the molars;³ pays no attention to the occurrence of the depression or ridges on other teeth; and regards the shovel-like form as a sign of advancing 'reduction' or 'hypoplasia' of the lateral upper incisors,⁴ assuming in this connection the old error that the 'foveola' was a *locus minoris resistenciæ* and as such a spot of predilection for caries.⁵

Arkövy examined in all 169 crania, with the following results, "so far as the cingulum is concerned:" There were in all 223 upper lateral incisors, of which Roman 8; from the period of "Völkerwanderung" 24; Avars 28; Hungarian from 1550–1668, 34; from the beginning of the XIX century 37; recent 37; old Greek 3; Maori 7; Sudan 1; Negro 2; Gipsy 6; Rumanian 3; and Bulgarian 2. This heterogeneous and quite insufficient material gave him the following results: "The occurrence of the cingulum (*Inc. lat. sup.*) shows progressive chronological increase; thus it was still wholly absent in the Romans; reached over 25 per cent in the time of the Völkerwanderung; over 39 per cent by the Avars; 53 per cent in the older Hungarians; over 70 per cent in those from the early part of the nineteenth century and 94.6 per cent in those of the recent time. It was found wanting "in tribes leading a

¹ Arkövy (J.)—Die Bedeutung des Diverticulum Tomes-Zsigmondyi, des Cingulum an den oberen lateralen Schneidezähnen und des Foramen caecum Molarum (Milleri) in phylogenetischer Beziehung. *Math. & Naturwiss. Ber. a Ungarn.*, 1903, XXIII; and *Österr.-Ungar. Vierteljahrschr. f. Zahnheilk.*, 1904, XX.

² Es war "höchst auffallend, dass an den oberen lateralen Schneidezähnen nur hie und da ein entwickeltes Cingulum, ja statt dessen im Gegensatze sogar eine Erhabenheit vorhanden war."

³ Das vielfach als Foramen caecum benannte "Grübchen" in der Mitte des Cingulums möge man nach Zuckerkandl 'Foveola' des Cingulums, ein charakteristisches Merkmal des oberen lateralen Schneidezahnes, nennen; den Sulcus und das Grübchen aber, welches an den Molaren vorkommt, bezeichne man als 'Foramen caecum (Milleri).'"

⁴ "Durch einen Zufall habe ich mich von dem Vorhandensein eines Reduktionszeichens dieser Zahngattung überzeugt, und das ist das Cingulum."

⁵ "Es ist allgemein bekannt, dass sowohl die Foveola als auch das Foramen caecum prädisponierende Stellen zur Entwicklung der Zahnkaries abgeben."

rude existence, such as the Maori and negroes, while on the contrary it is pronouncedly developed among cultured people"—as a type of which latter he pictures the shovel-shaped teeth of a Chinese. He pictures the upper arch of a Maori, in which the lateral incisors are without a "cingulum," but in which the overlooked medians are typically shovel-shaped. Arkövy also examined eleven skulls of the anthropoid apes. "In all these in the place of the cingulum there was found a well-developed convex smooth enamel surface."¹

The summary of Arkövy's conclusions, given here merely to show how far an imperfectly tested idea may lead an observer, were that besides the "diverticulum" of the premolars and the "foramen coecum" of the molars, the cingulum of the upper lateral incisors with the enclosed hollow are to be classed as phylogenetic hypoplasias of the enamel;² and that this formation "was not at all an integral factor of the original form of the lateral upper incisor, for the anthropoid apes show in this place a convexity, and neither any enamel defect nor a foveola." The cingulum and foveola moreover "are wholly wanting or occur only sporadically in wild tribes or among peoples leading a primitive rude life; and even if we are not able to determine when the cingulum originated, the increase in its frequency as we near the present time is apparent."³ . . . "It is probable that the development of the diverticulum, cingulum and foramen coecum

¹ "Zur Ergänzung wurden auch an anthropoiden Affen das Cingulum und Foramen coecum betreffende Untersuchungen vorgenommen, denn es hätte diese ganze Untersuchung desavouiert, wenn zufällig ein Cingulum oder Foramen coecum an denselben zu finden gewesen wären. Untersucht wurden 2 Gorilla, 4 Chimpanse, 3 Orang-Utang, 2 Hylobates. An allen diesen Fällen wurde an der Stelle des Cingulums eine gut ausgeprägte konvexe glatte Schmelzoberfläche gefunden."

² "Auf Grund der angeführten Angaben sollten das Diverticulum, das Cingulum mit der Foveola und das Foramen coecum in die Reihe der Schmelzhypoplasien aufgenommen werden, jedoch mit der Unterscheidung, dass diese phylogenetische Hypoplasien darstellen, während die bisher bekannten übrigen als pathologische Hypoplasien zu gelten hätten."

³ "Das Cingulum (*Incis. lat. sup.*) war durchaus nicht ein integrierender Bestandteil der Urform des lateralen Incisivus, da bei den anthropoiden Affen an dessen Stelle eine Konvexität, nicht aber eine Schmelzfalte und eine Foveola konstatiert werden kann. Es fällt aber gänzlich hinweg oder es kommt nur sporadisch bei wilden Stämmen oder bei Völkern, die eine rohe Lebensweise führen, vor. Wenn man auch das erste Auftreten des Cingulum nachzuweisen nicht imstande ist, so macht sich dessen graduellles Auftreten doch in jenem Verhältnisse bemerkbar, in welchem man sich der Gegenwart nähert."

was gradual and proportionate to the refinement of the mode of life of the different peoples."¹

The above conclusions, as will be shown later on, are wholly erroneous, and the merit of the article lies only in its being the first, though an accidental and mistaken essay, at a study of shovel-shaped incisors in some human races.

In 1906, in his great work on the "Diluviale Mensch von Krapina" Gorjanović-Kramberger describes (pp. 187-8) some permanent incisors, the forms of the lingual surface of which were peculiar. In his words,² "The incisor is really one of the most interesting teeth of the Krapina man. Its crown possesses certain primitive characteristics which in part remind us of anthropoids. There are seven of these teeth in the collection, and all of these are from the upper jaw, five being plainly median and two the lateral incisors. The middle incisors are broadest and most sculptured. . . . The lingual surface is more complex [than the labial]; in the first place this surface, on account of

¹ "Es ist aber wahrscheinlich, dass die Entwicklung des Diverticulum, Cingulum und Foramen coecum stufenweise zustande gekommen ist, und zwar in dem Grade, als die Lebensweise der betreffenden Völker sich raffinierter gestaltet hatte."

² "Der Schneidezahn ist wohl einer der interessantesten Zähne des Menschen von Krapina. Seine Krone besitzt eine primitive Charaktere, die uns zum Teil an die Anthropomorphern erinnern. Es liegen sieben Incisivi vor und alle diese stammen aus dem Oberkiefer, 5 davon sind offenbar mittlere, zwei aber seitliche Schneidezähne. Die mittleren Schneidezähne sind am breitesten und am meisten skulpturiert. Die Lingualseite dagegen ist komplizierter; vor allem ist diese innere Zahnfläche infolge der zurückgebogenen Seitenränder konkav und bei stärker zurückgehender Vorderfläche, geradezu tief konkav. . . . Die Kronenbasis ist verdickt und bildet einen Kegel, welcher durch einen oder zwei von dessen Spitze herabgehende Einschnitte in zwei oder drei Kegel zerlegt ist, oder es wird jener halbierte Konus noch durch je einen kürzeren Einschnitt an seiner Spitze gespalten. Dieser konischer Basalhöcker schmiegt sich an die Lingualfläche und von seiner Spitze aus verlaufen zur Mitte der Schneide zwei stärkere und zwei ganz flache Längsfalten. . . . Die seitlichen Schneidezähne sind in der Krone etwas schmaler, ebenso auch der basale Höcker. Es liegt ein besonders interessanter vor, an welchem wir alle vorher geschilderten Merkmale beobachten. Der Basalhöcker ist nämlich hier freistehend und sowohl von der Lingualfläche als von den Seitenrändern der Krone getrennt. Der Höcker reicht ferner bis über die Hälfte der Krone herab und hat in seiner oberen Partie eine Längsfurche. Auf der inneren Kronenfläche sehen wir eine leichte mittlere Rinne, die in die Einkerbung der Schneide führt. Als einen oberen lateralen I. betrachte ich auch einen ganz jungen Zahn, welcher alle besprochenen Merkmale der Krone zeigt, nur ist der Basalhöcker noch nicht ganz entwickelt gewesen. Wir sehen nämlich an der betreffenden Stelle der Lingualseite die zurückgebogenen Seitenränder des Zahnes je eine Falte bilden, die sich an der Medianlinie kaum noch berührten und zwischen sich (an der Basis) eine runde Öffnung hinterliessen."

the lateral borders of the teeth which are folded backward, is concave, and by a more strongly depressed surface, even deeply concave. . . . The base of the crown [on the lingual surface of the median incisors] is thickened, and forms a cusp, which is subdivided by incisures into two or three points. This conical basal cusp lies on the lingual surface and from its point run two strong and two faint vertical ridges towards the middle of the cutting edge. . . . The lateral incisors show a somewhat narrower crown as well as basal cusp. An especially interesting specimen shows all the above mentioned characteristics, but its strongly developed (double pointed) cusp stands free from both the lingual surface as well as the lateral borders of the tooth, and reaches in height to over the middle of the crown. The lingual surface of the crown shows a slight median groove which proceeds to the notch in the cutting edge. Another tooth which I look upon as a very young lateral upper incisor, shows all the above mentioned characteristics of the crown, with the exception that the basal cusp is not yet fully developed. The backward reflected lateral borders of the tooth are each seen to form a fold, which barely touch each other in the median line, and enclose between these at their base a round opening." Walkhoff, in Selenka's "Menschenaffen" (H. 9, 1902, 296), gives a good illustration of a portion of an upper jaw from Krapina, the incisors of which are distinctly shovel-shaped, with a strong basal cusp. Even the remaining canine bears a trace of the same feature besides showing a complete vertical median ridge.¹

Adloff himself, to whom we owe another very good treatise on the teeth,² in describing the permanent upper incisors of the "recent European," gives the following characterizations:³ "Their lingual

¹ "Auffallend ist auch beim Kiefer von Krapina die Vermehrung der Zahl der Höcker, eine Thatsache, welche sich sogar auf die lingualen Flächen der Schneidezähne erstreckt. Zwischen den starken Wülsten, in welche die Approximalfächen dieser Zähne nach der lingualen Seite zu übergehen, tritt vom Zahnhalse dieser Seite ein weiterer, sehr starker Wulst zwischen jene beiden. Dieser Wulst ist durch kleinere Längsrinnen häufig nochmals in kleinere Talons geteilt (Verstärkungsleisten). Auch die übrigen Zähne zeigen grosse Neigung zur Vermehrung der Schmelzfalten. Gelegentlich kommen solche noch an einzelnen Zähnen des heutigen Menschen vor."

² Adloff (P.)—Das Gebiss der Menschen und der Anthropomorphen. 8°, Berlin, 1908, II.

³ "Die linguale Zahnfläche ist schmaler als die Lippenfläche. Sie ist konkav, da die Seitenwände erhöht sind. Am Zahnhalse bildet das Cingulum ein sogenanntes Tuberculum dentale, das verschieden stark entwickelt sein kann. Das Cingulum oder die Basalleiste ist eine Erhöhung, die ursprünglich leistenförmig jeden Zahn am Zahnhalse umgeben hat, gewissermassen einen Sockel bildend, von dem aus der Zahn

surface is smaller than the labial. It is concave, as the lateral portions are elevated. On the neck the cingulum forms the so-called dental tuberosity, which may be variously developed. The cingulum or basal ring is an elevation which in a ridge form originally surrounded each tooth at its neck, forming in a way a socket from which the tooth builds itself up. It is a wholly primitive condition, which has perhaps played not an insignificant rôle in the phylogenetic development of the teeth. I speak of this purposely already in this place, because only a short time ago (1903) Arkövy, in a complete misunderstanding of the nature of the cingulum, represented the same erroneously as a reduction-phenomenon of cultured man. . . . Arkövy overlooks that it is precisely the latter form [the convexity or elevation at the base of the lingual surface] which represents the normally developed cingulum, while all other conformations are occasioned through its more or less advanced degeneration."

Adloff reverts to this subject also in other places. He accentuates (p. 12) the fact that the occasional basal cusp of the upper incisor, in all its variations, is formed from the cingulum, and is homologous with the basal cusp of the canine.

Adloff also examined the teeth in the skulls of various races, and saw that (p. 25),¹ "The lingual surface of the upper incisors showed sich aufbaut. Es ist ein durchaus primitiver Bestandteil, der bei der phylogenetischen Entwicklung des Gebisses vielleicht eine nichtunbedeutende Rolle gespielt hat. Ich habe dieses schon hier besonders hervor, weil erst kürzlich Arkövy (1903) in vollkommener Verkennung der Natur des Cingulums dasselbe als Reduktionserscheinung des Kulturmenschen gedeutet hat. Als Cingulum betrachtet nämlich Arkövy eine Schmelzfalte, welche sich an der linguale Fläche speziell des Incisivus lat. sup. von beiden Seiten gegen die Achsenlinie hinzieht und einen scharfen Winkel bildet, in dessen Tiefe sodann eine Foveola zur Entstehung gelangt. An Stelle dieser von ihm Cingulum genannten Bildung fand nun Arkövy bei Schädeln von Volksstämmen, die eine rohe Lebensweise führen, nicht nur keine Faltenbildung des Schmelzes, sondern im Gegenteil eine glatte Konvexität. Arkövy übersieht, dass gerade diese letztere Form das normal gebildete Cingulum vorstellt, während alle anderen Gestaltungen durch seine mehr oder weniger weit gediehene Rückbildung bedingt sind."

¹ "So zeigte die Lingualseite der oberen Schneidezähne nicht allzu selten Bildungen, die als Anomalie auch beim Europäer beschrieben wurden, die aber als regelmässige Erscheinung und in exzessiver Ausbildung, wie wir noch später sehen werden, beim Krapina-Menschen auftreten. Es war dann beim ersten Incisivus der Seitenrand erhöht, während vom Tuberculum zwei bis drei zusammenliegende, nach oben sich kegelförmig verjüngende Höckerchen nach der Schneide zu hinaufzogen (Tafel V, Fig. 20). Der zweite Schneidezahn war ähnlich gebaut, nur entbehrte das Tuberculum der Dreiteilung (Tafel V, Fig. 21a u.b.). Es konnte aber auch ein

not seldom conditions which as anomalies had also been described in the European, but which occur, as will be seen later, as regular formations and in excessive development, in the Krapina man. Thus the lateral borders of the median incisor were elevated, while from the tuberosity two to three oval ridges lying close together and diminishing from below upward, proceeded towards the edge of the tooth.¹ The lateral incisor was similarly formed, but the tuberosity was not divided. In other cases the tuberosity was wholly missing. Then the whole lingual surface presented a concavity which on either side was bound by a strongly raised lateral border. The two lateral borders came together on the neck of the tooth, forming a sharp angle. Between these two extremes, there were found all grades of transitional forms."

In connection with his studies Adloff examined also the teeth of the higher apes, both fossil and recent, but makes no reference to the feature under consideration; and he re-studied the teeth of the various then known forms of early man, among which those of Krapina, about the incisors of which he gives us the following information (pp. 39-40):² "The median incisors [of Krapina] are large and strong; in individual instances they doubtless exceed in these respects similar teeth of recent man; and especially noteworthy is their labio-lingual diameter, which, resulting from the unique configuration of their lingual surface, is remarkably elevated. From the neck rises a strong and massive

Tuberculum vollständig fehlen. Dann stellte die ganze linguale Fläche eine Konkavität vor, die jederseits von einem stark erhöhten Seitenrand umgeben war. Die beiden Seitenränder trafen dann oberhalb des Zahnhalses in einem spitzen Winkel zusammen. Zwischen diesen beiden Extremen waren alle möglichen Übergänge vorhanden."

¹ In Pl. V, Fig. 20, is shown a partly worn shovel-shaped median incisor of "a Negro," without any further characterization. Other approaching and well developed instances of shovel-shaped teeth are seen in Pl. II, fig. 4a European; Pl. III & IV, natives of New Britain; and Pl. VIII, teeth of Krapina.

² "Die mittleren Schneidezähne sind gross und kräftig; in einzelnen Exemplaren übertreffen sie zweifellos die gleichen Zähne des rezenten Menschen; insbesondere ist der labio-linguale Durchmesser infolge der eigenartigen Figuration der lingualen Zahnfläche bemerkenswert gross. Vom Zahnhalse aus erhebt sich massig und stark das Tuberculum, gewöhnlich durch eine stärkere Mittelfurche in 2 Höcker geteilt, die ihrerseits wieder durch schwächere Furchen noch einmal getrennt sein können. . . . Zu beiden Seiten des Tuberculum erhebt sich steil der Zahnrand. Die mittlere oberhalb desselben liegende linguale Fläche erscheint tief konkav. Es hat der Anschein, als ob der Zahn aus 2 Teilen besteht, dem Tuberculum und der vorderen Zahnfläche, welche letztere das erstere seitlich umfasst. Bei stark abgekauten Zähnen sieht man daher das freiliegende Dentin an den Seitenwänden rechtwinklig umgebogen."

tuberosity, usually divided by a deeper furrow into two cusps, which themselves may be divided again by secondary furrows. . . . On both sides of the tuberosity rises prominently the border of the tooth, while the median portion of the lingual surface is deeply concave. The whole appears as if the tooth consisted of two parts, the tuberosity and the tooth surface, the latter of which laterally embraces the former. In cases of worn-down teeth one sees the exposed dentine on the sides of the teeth bent at a right angle." The lateral upper incisors are of similar form as the median, only the tuberosity is freer, less subdivided and more independent.

No further original reference to the subject under consideration has been found by the author until 1914, when shovel-shaped incisors are referred to by Schwerz, in his report on the teeth of the early historic inhabitants of Switzerland.¹ Unfortunately Schwerz merely follows Arkövy and accepts all his conclusions. Also after Arkövy he makes no mention of the median incisor. Nevertheless he gives a better description of the condition. He says: "Besides the basal cusp the lateral upper incisor presents also other remarkable features. Frequently the lateral borders of its lingual side are strongly thickened and form then between themselves a triangular depression which may reach a considerable depth." Among 193 lateral upper incisors of the fifth to eighth century Alamanni of Switzerland, Schwerz noticed the "foveola" in 52, or 27 per cent. But in ignorance, evidently, of Adloff's observations on the subject, as well as of the American reports on shovel-shaped teeth, he concludes after Arkövy that this form is "to be regarded as a reduction manifestation, which has not yet made its appearance either in the anthropoids or among peoples living in a state of nature (Naturvölkern)."

The most recent and noteworthy contributions to Odontology, namely those of de Terra² and especially Bolk,³ while mentioning the shovel-shaped incisors, do not enter further into this particular subject and bring no new data.

¹ Schwerz (F.)—Ueber Zähne frühhistorischer Völker der Schweiz. *Vierteljahrschr. f. Zahnheilk.*, 1914, XXIV, 142-3.

² De Terra (P.)—Vergleichende Anatomie der menschlichen Gebisses und der Zähne der Vertebraten. 8°, Jena, 1911.

³ Bolk (L.)—Die Ontogenie der Primatenzähne. 8°, Jena, 1913;—Die Morphogenie der Primatenzähne. 8°, Jena, 1914.

II. WRITER'S OBSERVATIONS

The above is a brief digest of the literature on shovel-shaped incisors, and nothing further that would approach original has come to the author's attention. Writers on teeth such as Hunter, Owen, Magitot, Broca, Rosenberg, Cope, Osborn, Mathews, Gregory, Gidley and others have either not touched upon the feature at all, or only in a subordinate, by-the-side way. Shovel-shaped upper incisors have, it may therefore be said, been noticed by various observers—as in view of the striking nature of the condition could hardly be otherwise, and some initial efforts have been made at tracing the peculiarity racially and physiologically, but without definite results. Meanwhile the extensive craniological material passing through the writer's hands was constantly accentuating both the commonness and the frequently marked development of the condition in the American Indian. In 1912 a large collection of skulls from Urga showed that the feature was also present in the Mongolian, and there were indications of its presence in other groups of the yellow-brown people. After that the desirability of a more systematic examination into the subject became more pressing. But it was soon recognized that the examination of crania alone, with upper incisors so frequently lost, worn or damaged, was not sufficient, that it will be necessary to make ample observations on the living of different races, and that such observations should be restricted to young subjects in whom the teeth have not yet been affected by wear or decay. Opportunities for such observations developed on the writer's recent trip to the Far East, and the upper teeth of approximately 900 Chinese, Japanese and Hawaiian students and other subjects were examined, with interesting results. After the return, the study was extended to 1000 whites and to over 800 American negro subjects, the pupils of the Washington and Baltimore High and other schools,¹ as well as to the unworn teeth in the skeletal material in the collections of the Division of Physical Anthropology, U. S. National Museum; and the present report is the combined result of these researches. Observations were also extended to crania of

¹ Thanks for facilities extended are due to the Washington and Baltimore Boards of Education, and to Dr. John P. Murphy of the Washington Board, who accompanied the writer over the schools. A grateful acknowledgment for facilities rendered or assistance is further extended to the authorities of the Tsing Hua College, Young Men's Christian Association, and the Missionary Schools, at Peking; to Drs. K. N. Araki, Mitsuru Okada and the Tokyo Dental School, in Japan; to the authorities of the Bishop Museum at Honolulu; and to the Division of Mammals, U. S. National Museum.

anthropoid and other apes and of other mammals, of which the U. S. National Museum possesses large series, and that with considerable success, notwithstanding the fact that even more than in man the recognition of conditions in older subjects is interfered with in these forms by the wear of the incisors. It would have been of much advantage if the examinations could further have included a sufficiently large number of full-bloods from races such as the Melanesians, Australians, Negrito and African Negro, but these as well as further phylogenetic extensions of the study must be left for the future and probably for other observers.

DESCRIPTION OF SHOVEL-SHAPED TEETH.—The shovel-shaped conformation relates in man mainly, but not exclusively, to the upper incisors. When well marked it is almost generally observed in all the four teeth, but it may predominate in the medians or the laterals, or it may be present in either the median or lateral incisors alone, and in rare instances may affect or be marked in the two teeth of one side, or even in but one of the four teeth. It is present and fully or almost fully developed from the time the crowns of the teeth are formed within the alveoli (Pl. I), and hence wholly independently of the basal tuberosity (*Tuberculum dentale*), and is not materially changed during life except through attrition. It in no wise conveys any impression of degeneration, but rather that of redundancy and additional strength. The median shovel-shaped incisors are as a rule average to over-average in size and massiveness, and the same is true of normally developed lateral shovel-shaped incisors. In more or less degenerate lateral incisors, which as well known are not infrequent, the shovel characteristic may coexist with reduced volume of the tooth, in which case however it is itself reduced or deformed; such a tooth, especially when partly worn off, may in instances appear involute and even tubular.

A typical shovel-shaped incisor may be described as follows: It is generally a good-sized, strong tooth. The cutting edge is generally thicker and rather broader than in a non-shovel tooth, but otherwise it presents the same features. The labial surface of the crown is never long and narrow, but generally of relatively moderate length to short and rather broad. It further tends to be more convex than usual, especially from below upwards. Its sides are not straight or parallel, but more or less convex, so that the outline of the crown as viewed from the front is ovoid or oval rather than quadrilateral. This surface is occasionally perfectly smooth, but in other instances shows





Pl. I. Rim-and-Fossa Formation (Keilo-koilodonty) in Human Upper Incisors. Ridged Teeth.

Upper row: Median upper incisors; second row: lateral upper incisors; single tooth: immature median upper incisor. Fourth row, left: worn shovel-shaped median upper incisors from above; right: dorsal (labial) ridges, median upper incisors; fifth row: single and double lingual ridges on upper incisors; last row: linguo-gingival grooves.

two to three slight to well marked vertical enamel ridges with inter-jacent grooves which reach the cutting edge of the tooth and give this a serrated character. In rare cases, particularly on the median incisor, these dorsal ridges and furrows may be strikingly marked (Pl. I) and the two lateral elevations may resemble those on the borders of the lingual surface of the tooth. These dorsal ridges and depressions are also, according to indications, a generalized feature of the human, primate and mammalian upper incisors, though frequently nothing or but a mere trace of them may be perceptible. They will be dealt with on another occasion.

Due to the bulging enamel, the lateral surfaces of the shovel-shaped teeth are more convex from above downwards than in ordinary incisors; as in the latter, however, the enamel forms here marked semilunar notches, not reaching by from 2.5 to 4 mm. as high upon the root laterally as it does anteriorly and posteriorly.

The lingual surface of the well developed shovel-shaped incisor is very striking. Its moderate concavity from above downward is replaced by a triangular to rounded or oblong, deep fossa. The base of the fossa is formed by the free edge of the tooth, its summit reaches upwards near to the gum. The fossa is bounded laterally and generally also distally, hence on all sides, by a stout rim of enamel. In unworn teeth it may be clearly observed that it is not merely the lateral borders of the lingual surface which participate in this formation, but that the elevation of these borders is directly continuous with a more or less marked lingual thickening of the enamel of the edge, so that we have a complete enamel frame, with base below or distally, and sides converging upwards (Pl. I). But there are teeth, especially lateral incisors, in which the side thickenings alone are impressive.

The lateral overgrowth of the enamel in typical cases forms pronounced welts which bend or fold over the ordinarily built lingual surface, and which may actually meet or even overlap or unite in degenerate lateral incisors. These welts converge towards the median line at the summit of the crown, and there at first come in contact with and later fuse with the more or less pronounced basal heel or tuberosity. This enamel elevation or tuberosity exists also in non-shovel incisors, appears to represent the modified cingulum proper of the incisors, and varies considerably. It may be absent; it may be represented merely by some thickening between the meeting enamel welts, or by a small pearl-like tubercle, a little vertical ridge, a pair of

tubercles, a low to pronounced tuberosity, or finally a more or less free and marked cusp, the summit of which may in turn be single, cleft in two or subdivided into several points. And proceeding from (but in reality to) the tuberosity we may occasionally discern one, or more frequently two (on median incisor) slight to well marked enamel ridges, reaching distally to or part of the way toward the cutting edge of the tooth (Pl. I). These ridges, as well as the tuberosity, are of much more interest and importance than might at first seem, and will be reserved for special consideration.

The lingual fossa of shovel-shaped incisors, as may well be seen in worn teeth, is not conditioned or accompanied by any loss of dentine or enamel (Pl. I). It is produced by marginal overgrowth of the enamel with more or less of its subsequent lateral folding over the lingual surface of the tooth; and the result of the whole process is not any phylogenetic "reduction" of the upper incisors, but rather their functional strengthening. It is not a hypoplastic but evidently more of a hyperplastic condition.¹

Subdeveloped and transitional forms of shovel-shaped incisors are common. In a large series of teeth of perhaps any race there may probably be found all forms, from the complete absence of a fossa and enamel frame to their most typical development. As with other descriptive features there are no dividing lines that would give us natural subdivisions of these forms for classification. Zuckerkandl's attempt in this direction is not fully satisfactory. Yet we can approach the truth by some simple grouping of the variations. The writer, as a matter of experience, has adopted the terms *shovel* (*s*) for all the better developed grades; *semi-shovel* (*ss*) for the less well developed; and *trace-shovel* (*tr.*) for slight but distinct indications.

Aberrant forms are also not infrequent. In some cases the lingual fossa may approach a scoop-like concavity, or a trough-like depression, or a rounded pit. The juncture of the two lateral enamel folds may be one-sided (Pl. I); the two folds may not be wholly symmetric, and they may taper out before reaching the cutting edge of the tooth. The summit of a deep fossa may be prolonged into a small canal or infundibulum, and there may be still other variations or anomalies, most of them however of little if any importance.

In the developing tooth, the crown with the raised lateral lingual

¹ And can hardly be, as sometimes alleged, a predisposing factor to caries, for it is well protected by enamel; in his many years' attention to the subject the writer has not found a single instance of decay beginning in this depression.

enamel borders, is separated from the tuberosity portion by an oblique fissure on each side. Traces of one or more, seldom both, of these fissures may occasionally be traced on the fully developed tooth as faint to well noticeable grooves.

SHOVEL-SHAPED INCISORS IN CRANIA OF AMERICAN INDIANS, ESKIMO,
MONGOLIANS AND MELANESIANS

The total number of individual teeth embraced in this series is a little over 700. This necessitated the handling of upwards of 8,000 crania, such is the bad state of conservation and preservation of the front teeth in skeletal material from burials. In a large proportion of cases the front teeth are missing altogether or but one or two may be remaining; while in another large class of specimens they are so worn, in height or on their lingual surface (overbite), that a correct determination of the original features of the surface is risky, if not impossible.

In order to convey as far as possible the precise meaning of the terms to be used it will be well to give the following additional explanations: Under the term 'shovel-shaped' are included all incisors whose lingual surface showed the enamel rim with the enclosed fossa well developed. The term 'semi-shovel' was applied to all teeth in which the enamel rim was distinct, but the enclosed fossa was shallow. The term 'trace' covers all those teeth in which there were distinct traces of the enamel rim, but which could not be classed as yet as 'semi-shovel.' Finally as 'no-shovel' were recorded all those incisors in which there was either no perceptible trace of rim and fossa, or in which traces of these were so faint or imperfect as not to deserve a special characterization.

The results obtained on the well preserved teeth are given in the following table:

PERMANENT UPPER INCISORS OF AMERICAN INDIANS AND
OTHER COLORED RACES (SKELETAL MATERIAL)

People	Median Incisors					Lateral Incisors				
	Total Number of Un- worn Teeth Exam- ined	Shovel- shaped, Percent	Semi- shovel, Percent	Trace, Percent	No Shovel, Percent	Total Number of Un- worn Teeth Exam- ined	Shovel- shaped, Percent	Semi- shovel, Percent	Trace, Percent	No Shovel, Percent
Indians.....	(277)	67	24	9	2	(300)	76	17	6	1
Eskimo.....	(40)	37.5	47.5	15	—	(37)	57	43	—	—
Mongolian...	(24)	62.5	29	8.5	—	(24)	75	25	—	—
Melanesian ..	(6)	33	33	—	33	(6)	6.7	—	33	—

The figures show the proportion of shovel-shaped incisors in the American Indian to be very considerable, nearly as great, as will be shown later on, as that obtained in the main Asiatic representatives of the yellow brown race. There are indications of tribal differences in the frequency of the character, it being more common, for instance, among the Pueblos than among the Plains Indians; but the exact conditions in these respects can only be determined by future studies on large numbers of full-blood children and adolescents of these different groups.

The Eskimo show a perceptibly lower proportion of typically developed shovel-shaped incisors than do either the Indians or Mongolians. Why this should be so is as yet not apparent.

The number of Melanesian teeth in good condition is too small to permit any conclusions, except that both a total absence of the character, as well as its presence in a well developed form are found in these people.

SHOVEL-SHAPED TEETH IN WHITES AND OTHER RACES, IN THE LIVING

The whites utilized for the present study represent American children of the second to more generations, with a sprinkling of Jewish and other subjects of more recent advent. The American Negro subjects embrace all colors, that is, all the mixtures met with in such a city as Washington; about one-half of these were mulatto and lighter shades, and about one-half darker, quadroon to full-blood. Of full-bloods the total includes probably less than one-third. The Hawaiians to whom this report applies were full-blood Hawaiians according to their own estimation and as far as it was possible to determine; but it should be born in mind that even those Hawaiians who may be free of admixture since the discovery of the islands do not represent a pure ethnic group, but carry in all probability the blood of yellow-brown, Indonesian and even Melanesian and Negrito ancestry. The Chinese subjects were from all parts of China, though a larger number came from Chihli and other northern provinces than from those of the south. The Japanese represent, as already stated, young workmen of Kyoto, and in addition students from many parts of Japan.

All observations were carried out by the writer himself, within six months' time, and under the best light and other conditions. They apply to upper teeth only, the lower incisors in the living presenting a poorer field for examination. The same standards were used as in

the study of cranial material. In the actual examinations it was found, however, that considerable care had to be exercised to arrive at an approximately correct estimate of conditions, especially in the intermediate grades. The work calls for good eyes with good light, besides experience. The method was for the subject to face the examiner in the best possible light, and then throw his head sufficiently backward, at the same time opening the mouth as wide as possible so as to show the inner surface of the teeth to the best advantage. With children it was necessary for the examiner to sit on a stool.

The reliability of the method was tested in a measure by separate analysis of the data obtained on the same class of subjects on different days, and some of the results are shown in the table on p. —. They are, it will be noted, quite harmonious; and it does not seem probable that with equal care the results of any other observer on the same subjects would have materially differed. The development of some individual bias in one or another direction, however, would be quite easy, as in the case of other visual observations.

AMERICAN WHITES.—The data secured by the above mentioned examinations show that in the American Whites, well-developed shovel-shaped upper incisors are rare, occurring in not more than 1 per cent of the individuals if we take both sexes together, and in only a little over 1 per cent of either the median or the lateral incisors if we consider the teeth themselves. Should we take the semi-shovel and shovel-shaped forms together, we find that they still involve only 5 per cent of the persons examined, while fully 50 per cent of the subjects showed teeth that had to be classified as 'no-shovel.'

A glance at the data in the two sexes shows interesting sexual differences. These differences, while not great, are so regular that they can not be accidental. The males, it is seen, show a perceptibly greater tendency towards the shovel-shaped formation than the females. They present a higher percentage of 'shovel-shaped,' of 'semi-shovel' and even of 'trace' incisors, and a smaller proportion of 'no-shovels.'

About one fourth of the subjects in each class presented miscellaneous conditions, in which the conformation of the lingual surface of the median teeth differed from that of the lateral, or in which the teeth of one side or one of the four teeth, differed perceptibly from the others either in possessing or not possessing the shovel-shaped form in some degree. Additional notes on these cases will be given later.

AMERICAN NEGRO.—Due to a greater scarcity in the summer of available colored boys and young men than girls, it was not possible

FREQUENCY OF SHOVEL-SHAPED INCISORS IN THE LIVING

Males										Females					
Race	Shovel-shaped	Semi-shovel	Trace	No Shovel	Med's Shov. Lat's Less to None	Lat's Shov. Med's Less to None	Misc.	Race	Shovel-shaped	Semi-shovel	Trace	No Shovel	Med's Shov. Lat's Less to None	Lat's Shov. Med's Less to None	Misc.
WHITES (500).....	Individuals: (5)	(27)	(94)	(238)	(1)	—	(135)	WHITES (500).....	(3)	(16)	(82)	(277)	(5)	(1)	(116)
	Percent: 1.0	5.4	18.8	47.6	0.2	—	27		0.6	3.2	16.4	55.4	1.0	0.2	23.2
AMERICAN NEGRO(307)	(12)	(20)	(78)	(117)	(1)	(1)	(78)	AMERICAN NEGRO (500)	(16)	(31)	(117)	(209)	(1)	(1)	(125)
	4.0	6.5	25.5	38.0	0.3	0.3	25.5		3.2	6.2	23.4	4.3	0.2	0.2	23.8
HAWAIIANS (21).....	(7)	(3)	(1)	(2)	(2)	(5)	(1)	HAWAIIANS (38).....	(10)	(11)	(1)	(2)	(4)	(4)	(6)
	33.0	14	5	10	10	24	5		26.0	29	3	5	10	10	16
Yellow-Browns CHINESE (547).....	(289)	(95)	(6)	(33)	(70)	(12)	(42)	CHINESE (104).....	(65)	(9)	—	(2)	(21)	(5)	(2)
	53.0	17.4	1.1	6	13	2.2	7.7		62.5	8.7	—	2	20.2	4.8	2
JAPANESE (172).....	(119)	(27)	—	(5)	(15)	(4)	(2)	JAPANESE	—	—	—	—	—	—	—
	69.2	15.7	—	3	9	2	1		—	—	—	—	—	—	—

FREQUENCY OF OCCURRENCE OF VARIOUS GRADES OF
SHOVEL-SHAPED INCISORS, BY TEETH

	Median Incisors				Lateral Incisors			
	Shovel-shaped	Semi-shovel	Trace	No Shovel	Shovel-shaped	Semi-shovel	Trace	No Shovel
WHITE MALES (500)	<i>Teeth:</i> (14)	(76)	(245)	(665)	(14)	(88)	(364)	(500)
= 2000 incisors	<i>Per-</i>							
= 1000 medians and	<i>cent:</i>							
1000 laterals	1.4	7.6	24.5	66.5	1.4	8.8	36.4	50.-
WHITE FEMALES (500)	(26)	(52)	(218)	(704)	(10)	(74)	(299)	(596)
= 2000 incisors								
= 1000 medians and								
1000 laterals	2.6	5.2	21.8	70.4	1.-	7.4	29.9	59.6
AMERICAN NEGRO MALES (307)	(30)	(47)	(204)	(337)	(28)	(79)	(235)	(260)
= 1228 incisors								
= 618 medians and								
laterals	4.9	7.6	33.-	54.5	4.5	12.8	38.-	42.1
AMERICAN NEGRO FEMALES (500)	(36)	(80)	(326)	(560)	(38)	(111)	(354)	(475)
	3.6	8.-	32.6	56.-	3.8	11.1	35.4	47.5
HAWAIIAN MALES (21)	(18)	(16)	(2)	(6)	(24)	(6)	(2)	(6)
= 84 incisors								
= 42 medians and								
laterals	42.9	38.1	4.8	14.3	57.1	14.3	4.8	14.3
HAWAIIAN FEMALES (38)	(28)	(34)	(6)	(8)	(30)	(29)	(5)	(2)
= 152 incisors								
= 76 medians and								
laterals	36.8	44.7	7.9	10.5	39.5	38.2	6.6	2.6
CHINESE MALES (547)	(724)	(256)	(14)	(85)	(622)	(263)	(16)	(104)
= 2188 incisors								
= 1094 medians and								
laterals	66.2	23.4	1.3	7.8	56.9	24.-	1.5	9.5
CHINESE FEMALES (104)	(172)	(26)	(2)	(8)	(143)	(28)	(2)	(7)
= 416 incisors								
= 208 medians and								
laterals	82.7	12.5	1	3.8	68.8	13.5	1	3.4
JAPANESE MALES (172)	(268)	(62)	-	(14)	(250)	(70)	-	(14)
= 688 incisors								
= 344 medians and								
laterals	77.9	18.-	-	4	72.7	20.3	-	4

TESTS OF METHOD OF EXAMINATION
WHITES

<i>Females</i>									
Place	Shovel all 4	Semi- shovel	Trace	No Shovel	Med's Shovel Lat's. Less to None	Lat's. Shovel Med's. Less to None	Misc.	Place	Shovel all 4
Central High School, 1st day (222)...	0.5	2	16	62	1.5	-	19	Central High School, 1st day (222)...	0.5
Central High School, 2d day (114)...	1	4.5	16	56	-	-	23	Central High School, 2d day (114)...	1
Various (164).....	0.6	4.3	16	50	3	0.6	25.5	Various (164).....	0.6
<i>Males</i>									
Place	Shovel all 4	Semi- shovel	Trace	No Shovel	Med's Shovel Lat's. Less to None	Lat's. Shovel Med's. Less to None	Misc.	Place	Shovel all 4
Central High School, 1st day (220)...	1	6.5	17	52	-	-	24	Central High School, 1st day (220)...	1
Central High School, 2d day (71)...	-	4	24	46.5	-	-	25.5	Central High School, 2d day (71)...	-
Walter Reed Hospital, 1st day (106).....	1	5	19	47	1	-	27	Walter Reed Hospital, 1st day (106).....	1
Walter Reed Hospital, 2d day (78).....	1	4	14	55	-	-	25.5	Walter Reed Hospital, 2d day (78).....	1

to get a complete five hundred of the former as intended; but the series of over three hundred is sufficient to show the main conditions. During the examination the subjects were subdivided into 'dark' and 'lighter,' with the anticipation that the former, who included a fair percentage of full-bloods, might show different conditions; but this expectation was not realized to any degree, hence in the tables the data on the two classes are presented as a whole. What differences there were, indicated a slightly greater tendency towards the shovel form, as well as towards some other primitive features (Krapina-like teeth, etc.), in the darker subjects.

The total results show that in comparison with white Americans, four times as many colored males as well as colored females show the well developed 'shovel-shaped' teeth; that a higher percentage of both classes, than in whites, show also the 'semi-shovel' and 'trace' forms; and a considerably smaller percentage than in the whites—though still representing two fifths of the subjects—show upper incisors plainly, moderately concave from above downward and flat or nearly flat from side to side, with no plainly distinct trace of the shovel form.

The sexual differences agree with those of the whites—there is a slightly greater tendency towards the shovel-shaped form in the males.

The examination of this class of subjects left the impression that a further study of the size, form and modelling of the negro incisors (as well as other teeth) would well repay the effort.

HAWAIIANS.—The data obtained on the upper incisors of the Hawaiians show marked differences from those of both the American Whites and American Negro. Shovel-shaped upper incisors occur in nearly one third of the subjects, and if we take shovel and semi-shovel together, they are seen to exist in one half of the individuals, while individuals with no-shovel teeth are reduced in each sex to one out of ten. These conditions are found to be even more accentuated when we consider the proportions of teeth rather than individuals.

As to sex, similar differences as in the whites and negroes are observable so far as the well developed shovel form is concerned, but the females exceed the males in the proportion of 'semi-shovels.'

The old Hawaiian skulls at the Bishop Museum, many of which come from other islands than that where the examinations on the living were made (Hawaii), showed the shovel-shaped condition of the upper incisors less frequently, but as in the majority these teeth were missing and in others were more or less worn, a true estimate of conditions was impossible. In the large collection of Hawaiian

crania in the Y. S. National Museum, there is hardly a specimen in which the upper incisors have not been lost after death, or so worn off as to make an appreciation of their former modelling difficult or impossible.

CHINESE.—In the Chinese the proportion of shovel-shaped teeth was found to be very great, 'no-shovel' formation existing in less than 5 per cent of the whole number of individuals examined. The percentage of 'semi-shovels' is much smaller than that of the fully developed form, and that of 'traces' is still less. Besides this the proportion of cases in which one pair of the incisors shows a well developed shovel form while the other pair possesses less or none of that character, rises higher than in any of the other series.

The relation of conditions in the females to that of the males is the reverse of what was observed in all the other groups so far mentioned. If we take individuals with shovel and semi-shovel upper incisors together, these differences almost disappear, which might seem to imply the possibility that there may have been some unevenness in valuation; but the differences reappear and that even in a more marked form when we consider the proportions of the different forms in the teeth themselves (table p. 453). The Chinese girls and young women who were examined, were essentially from Peking, while many of the boys and young men were from other parts of China, which may make a difference. The students in Tsing Hua College, who come from all parts of China and from better families, showed a somewhat less proportion of shovel-shaped teeth than the young men at the Young Men's Christian Association, who are also mainly Pekingese. The truth in the case can only be determined by further study.

JAPANESE.—The writer had no occasion to examine Japanese young women, for when he returned to Japan for that purpose the schools were closed for the spring vacation; and the same cause accounts for the somewhat small number of Japanese males. Yet the number of the latter is sufficient to show that conditions in the Japanese, so far as the shovel-shaped forms of upper incisors are concerned, are much the same as in the Chinese—possibly even a little more accentuated. In only 3 per cent of the cases seen in the Japanese were the teeth free from all trace of shovel-shaped formation.

SUMMARY.—The data secured by the writer show that the proportion of well developed shovel-shaped upper incisors in white Americans is almost insignificant, that the proportion rises perceptibly, yet not

greatly, in the American negro; that it is very much larger in the Eskimo and especially in the American Indian, as well as in the Chinese, Japanese, and, the writer has satisfied himself, also Koreans, all branches of the Yellow-brown stock; and that it is near medium, though nearer the Yellow-browns than the Whites, in the Hawaiians. Shovel-shaped upper incisors occur also among the Melanesians, though we know not as yet with what frequency. One Negrito skull with but partly worn front teeth in the U. S. National Museum shows, too, plain traces of the condition. In view of all these facts, with indications of the occurrence of shovel-shaped incisors in prehistoric races, it seems safe to conclude that the conformation of the lingual surface of the upper incisors is a condition of considerable morphological importance, and one that according to indications may not only prove of much value to anthropology, but also, as will be shown later, to biology.

IRREGULARITIES.—As already alluded to, the characteristics of the median and lateral upper incisors, in relation to the shovel-shaped feature, are mostly harmonious, that is, participated in, and that to a similar degree, by all the four teeth. But there are not infrequent cases in which the lateral incisors behave more or less differently from the median, and there are even instances in which one tooth, or the two teeth of one side, or every tooth, shows a distinct form of the lingual surface.

In some groups, in a majority of these irregular cases the median incisors show the shovel-shaped characteristic in a more pronounced form than the laterals; in others the laterals show the condition more marked than the medians. The latter condition was observed more especially amongst the Hawaiians, though the grouping there of the occurrences may have been accidental; but it was also manifest in the Indian, Eskimo and Mongolian skulls. Among the 547 Chinese males, on the other hand, there were as many as 70 individuals in whom the median incisors showed a well-developed shovel form while the laterals presented the same form in a lesser degree, or not at all; while there were only 12 subjects who showed the reverse conditions (table p. 452). Among the Chinese females similar figures were 21 and 5, among the Japanese males 15 and 4, among the white females 5 and 1.

Of the still more irregular cases, it was commonly one of the lateral incisors which failed to come up to the standard of its mate and of the medians. Thus we would have formulas such as "Medians *s*, r. lateral *ss*, l. lateral *tr*;" or "Medians *ss*, r. lateral *no s*, l. lateral *tr*;"

—"Medians *tr*, r. lateral *ss*, l. lateral degenerate;" "r. median *s*, r. lateral *s*, l. median *tr*, l. lateral *tr*," etc.

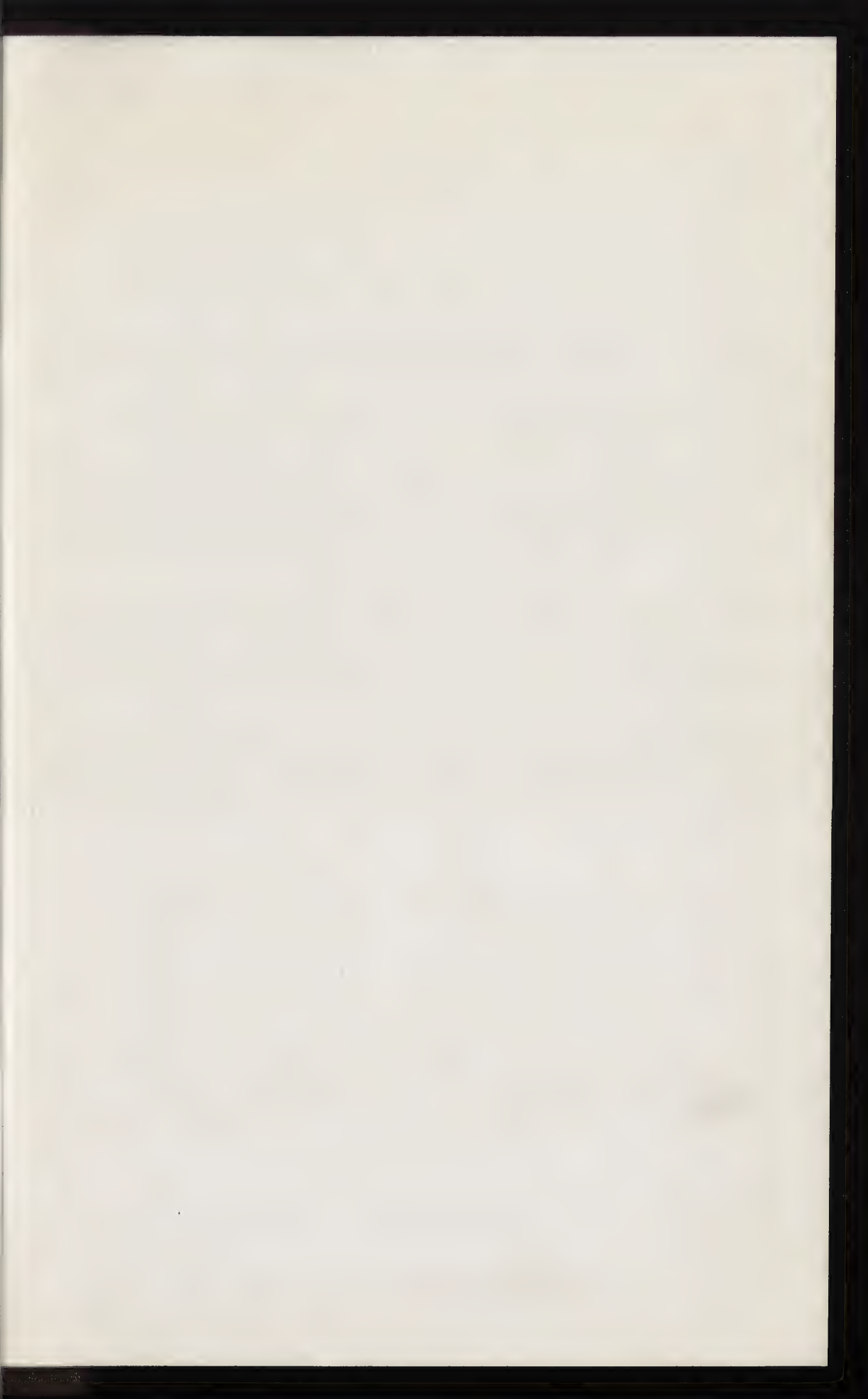
SPECIAL CASES.—Of the special cases, the most remarkable was that of a mixed-blood colored girl, Edna Smallgood, aged about fourteen, of Washington, D. C., in whom all the six upper front teeth, incisors and canines, showed a well-developed shovel-shaped form. Another unique subject was a colored girl, mixed blood, about 17 years old, who had a supernumerary upper incisor on the right side of exactly the same form and size as the lateral, and in whom all the regular and rather macrodont teeth, as well as the supernumerary, were of a well and evenly developed shovel-shaped type.

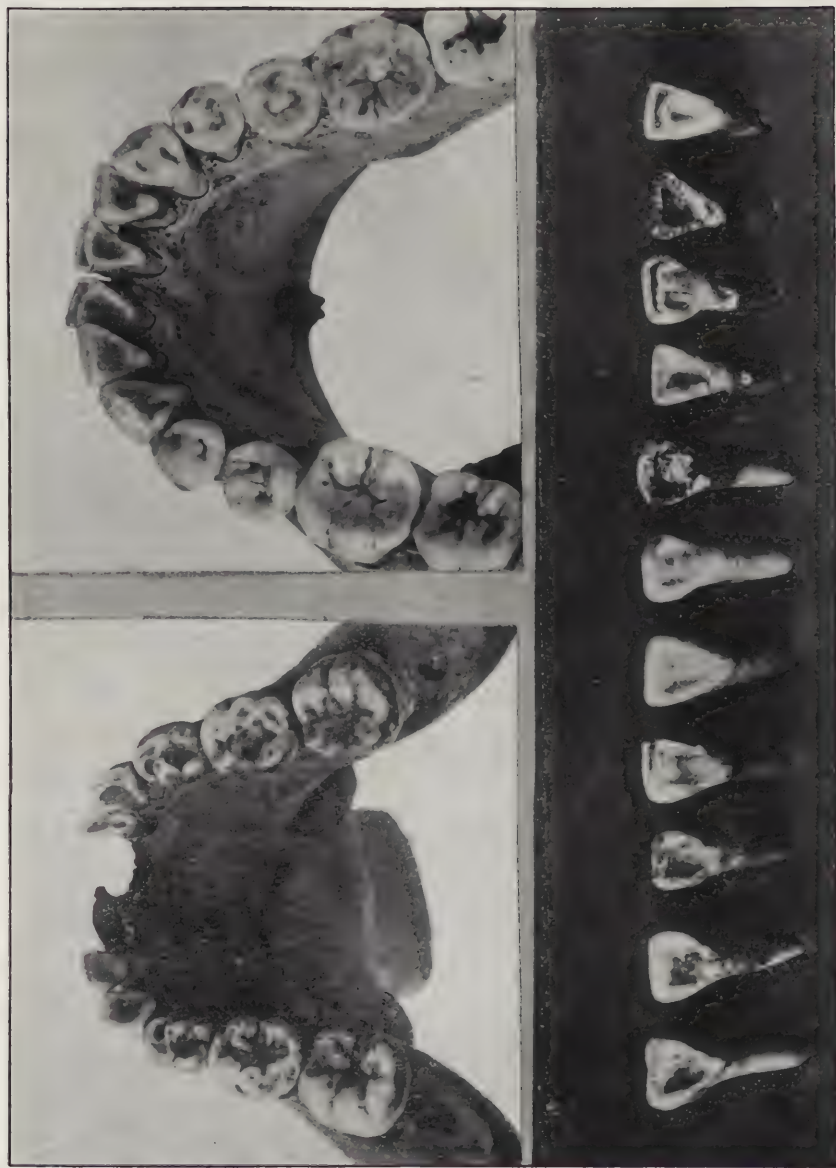
LOWER PERMANENT INCISORS. DECIDUOUS INCISORS.
OTHER TEETH

Attention thus far has been given only to the upper human incisors, but the shovel-shaped condition may occasionally be seen also in the lower human incisors. If it has not as yet been signalled in these teeth it is only because of its rarity in the white races, because of the very frequent wear or loss of the lower front teeth in skeletal material proceeding from other stocks, and because the whole subject has as yet received but a casual attention.

An inspection of 73 lower Indian incisors that have been lost from their skulls and are kept separate in the U. S. National Museum, shows that no less than 27 of these teeth, mostly medians, present a distinct trace of the shovel-shaped condition (both fossa and rim) and in 5 of these the condition is sufficiently accentuated to be termed 'semi-shovel'; 47 teeth, or 60 per cent of the series, show a smooth surface. As the occurrence of the shovel-shaped feature in the upper incisors of the Indian is almost general, it is seen that the involvement of the lower teeth is much less frequent as well as less pronounced; yet it is by no means uncommon. One of the Indian lower incisors (last on right, Pl. II) shows an oblong median lingual fossa without a rim, precisely such as may be observed, as will be shown later on, in some lower mammals (see Pls. III, IV).

DECIDUOUS INCISORS.—An extension of the observations to the deciduous incisors in the Indian crania, showed that the rim-and-fossa feature of the lingual surface occurred also in these teeth. Its incidence and degrees are shown in the following figures. The condition, while not very pronounced, is seen to exist also in the deciduous teeth, and that quite frequently:





Pl. II. Rim-and-fossa formation in lower front teeth.

Above, left: Indian child from Peru (293,170) — Lower deciduous incisors and especially canines shovel-shaped; right — Indian female, Arkansas (262,578): Lower incisor shovel-shaped; canines show plain traces of fossa with a good rim — the fossa is partly obscured by the median ridge. Below: Lower Indian incisors; the one at the right end of the line, and also the fourth from the right, show former like those in apes. Several of the teeth show median ridges.

LOWER DECIDUOUS INCISORS OF AMERICAN INDIANS

Number of Skulls	Number of Incisors		Shovel-Shaped		Semi-Shovel		Plain-Trace		No Shovel	
	Med.	Lat.	Med.	Lat.	Med.	Lat.	Med.	Lat.	Med.	Lat.
(17).....	22	19	—	—	—	2	14	10	8	7
Per cent.....			—	—	11	64	52	36	37	
Per cent, total.....	(41)		—		5	59		37		

UPPER DECIDUOUS INCISORS OF AMERICAN INDIANS

Number of Skulls	Number of Incisors		Shovel-Shaped		Semi-Shovel		Plain-Trace		No Shovel	
	Med.	Lat.	Med.	Lat.	Med.	Lat.	Med.	Lat.	Med.	Lat.
(17).....	24	11	—	—	—	—	16	5	8	6
Per cent.....							67	45	33	55
Per cent, total.....	(35)		—		—		60		40	

OTHER TEETH.—But the formation of a lingual rim and fossa—*keilodonty*¹ and *koilomorphy*² is by no means limited to the incisors. Further and closer examinations show that, reduced or masked, it is also common to the canines, and if we examine the remaining teeth more closely we may observe occasionally indications of the same feature on the bicuspid, and even on the molars. In the canines the rim and hollow feature may in some instances be so well marked that the teeth could be taken for shovel-shaped incisors. In other teeth, however, the indications may be so faint or obscured by other features that the student may not at first be able to differentiate and perceive them; but if the whole subject of the lingual rim and fossa formation be studied progressively from the incisors backward, with the help of a good glass, and on many teeth of different derivation, the connection of certain elevations and depressions on the more posterior teeth with the rim and fossa formation of the incisors cannot be mistaken.

At this point the significance of the rim and fossa feature ceases to be merely of group or racial importance and assumes a farther reaching morphological and phylogenetic significance. It is an old, widely generalized, and at present one of the fundamental, even though not always apparent, features of tooth structure. The subject will be dealt with more closely when we come to the description of certain other features of the detailed modelling of the teeth, particularly the

¹ χεῖλος = rim, lip.

² κοῖλος = a hollow.

median lingual ridge which also can be traced on every tooth in the human denture.

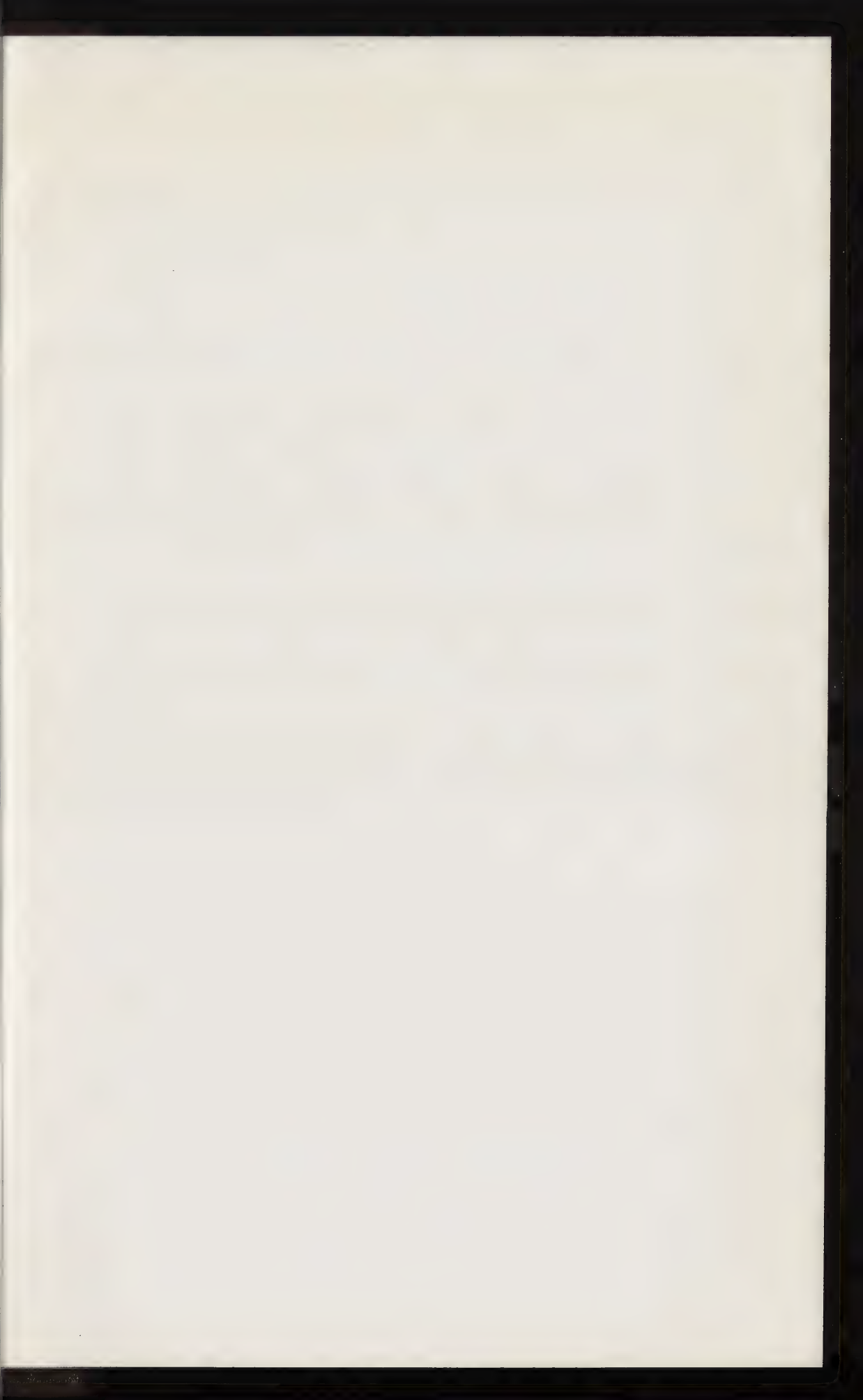
KEILO-KOILOMORPHY IN ANIMALS

PRIMATES.—Rimmed and hollowed incisors are not limited to man. They are present also in a good many of the apes, and in many of the lower mammals. Typical keilo-koilomorphy (rim and fossa condition), such as found in man, occurs however in none of the existing or known anthropoid apes. The deficiency applies particularly to the rim formation, for the lingual fossa in a more or less modified form is present in all the species. This almost forces the suggestion that the direct line of human ancestry ought to show a more human-like keilo-(rim formation) as well as koilomorphy (hollowing out of the lingual surface of the front teeth), and that as both of these features are different in the so far known anthropoid apes than in man, the real ancestral line of man has not yet been discovered. Though it may also be that the development of the typical human rim with the typical human fossa was one of the features of the evolution of man's teeth from those of his precursors.

The above should not convey the impression that the rim formation is wholly or even greatly deficient in the anthropoid apes. Its presence may in reality be detected in all the known species of which we have better preserved front teeth, and that particularly on the lateral upper incisors. There is a considerable individual variation in this respect, and single teeth in some individuals approach, though without reaching, the human formation.

A feature of the anthropoid ape teeth which interferes with or partly obscures the rim and hollow formation of the lingual surface, is the development of the median lingual ridge. This ridge is in general much more conspicuous than in man. It divides the lingual fossa of the incisors into two lateral portions, and when especially developed it quite overshadows the depression, as well as the slight to moderate rim formation. Incisors of the true living anthropoid apes, the chimpanzee, gorilla and orang, in general resemble more some of the teeth of the man of Krapina and also occasionally those of the negro, than they do those of modern man of the white or yellow-brown races.

A notable feature of anthropoid apes, and also of lower monkeys, is that the lower incisors participate in the rim and fossa formation decidedly more than they do in man. In some specimens these features are even more plain on the lower than on the upper teeth.

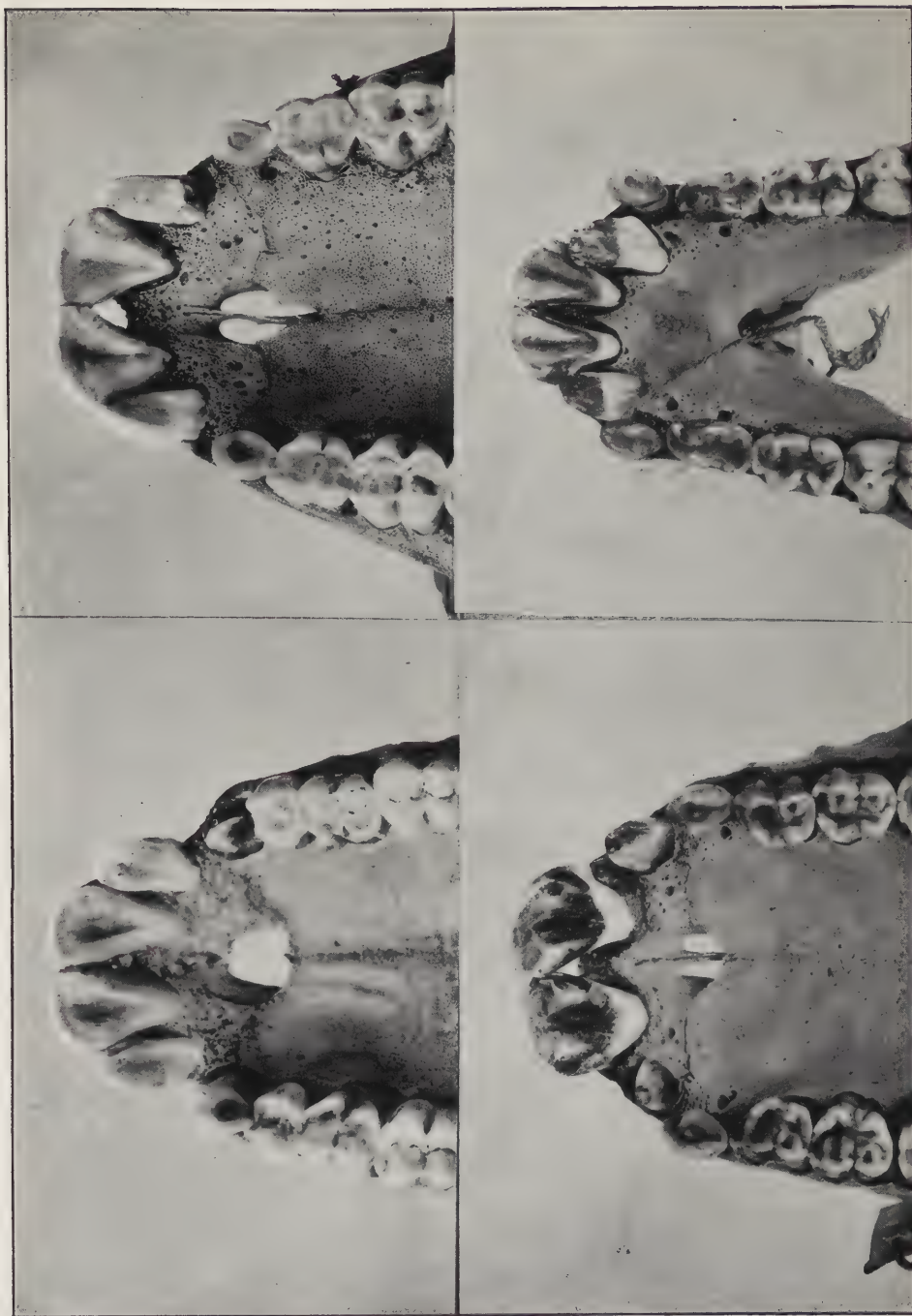




Pl. III. Keilo-kilodontology and other Interesting Conditions in Apes.

Left: Orang, ♀, 22,149 — Rim and fossa formation, especially on median incisors; pronounced median lingual ridge; triconodont character indicated on laterals. Right: Presbytis shistacea, 99,117. Marked rim and fossa development in upper incisor.





Pl. IV. Shovel-shaped Incision in Apes.

Above: Left — *Macacus maurus*, ♀ 114,645; Right — *Cercopithecus fuliginosus*, ♂, 123,824. Below: Upper and lower jaw of a ♀ *Macaque* from Borneo, 198,299.

The gibbon, which seems to be kept in the anthropoid series only by sufferance, shows aberrant conditions. The lingual fossa is developed but slightly on the upper median, and only in weak traces on the upper lateral incisors; and the rim is marked only along the proximal edge of the lingual surface, though under the magnifying glass it is seen to extend all around.

OLD-WORLD APES.—In the catarrhine apes we find species in which the rim and fossa formation of the lingual surface of the incisors seems in general absent or but faint, though even in these species we may come across individuals in which these features are more pronounced. But in the majority of the species both rim and fossa are more or less well represented on both the upper and the lower incisors and the teeth of some individuals resemble very closely, more closely than the teeth of any anthropoid ape, the shovel-shaped teeth of man. This is particularly the case in some of the Presbytes (Pl. III), but pronounced fossa with thick rims is frequent also in the baboons, the macaques and the *Cercocebi* (especially *C. fuliginosus*) while less marked forms occur in the *Cynopithec*i and various other monkeys. As amongst the higher apes however, so amongst these monkeys, studies in this respect are greatly interfered with by the early lingual wear of the front teeth, so that even the examination of such a large series of specimens as that available in the U. S. National Museum is insufficient for any statistical determinations; but it is plain that the fossa and rim formation is widely represented in the catarrhine monkeys, and as in man and the higher apes, may well be regarded as among the fundamental morphological features of tooth formation of these species.

An examination of the numerous illustrations in D. G. Elliot's "A Review of the Primates" (*Monog. Am. Mus. Nat. Hist.*, 1912-'13, 3 vols.), notwithstanding the inclusion of many specimens with worn denture, has shown the presence of shovel-shaped teeth, more or less, in the following:

Plate XXXI, Vol. 1—*Cacaj*as *calvus*, Amer.; trace of *s* in upper¹ lateral incisors.

" " 2—*Cebus malitiosus*; trace.

" XI, " "—*Papio hamadryas*; trace.

" XVII, " "—*Theropithecus obs.*; present in upper median incisors.

" XVIII, " "—*Cynopithecus nig.*; present in upper median incisors.

" XXX, " "—*Rhinostigma hamlyni*—*s* present in upper medians; also trace in lower medians.

" XXXII, " "—*Lastopyga victicans*—*s* present in upper medians.

" II, " 3—*Erythrocebus alb.*; trace *s* present in upper medians.

¹ Conditions of the lower teeth in most of these specimens was not determinable.

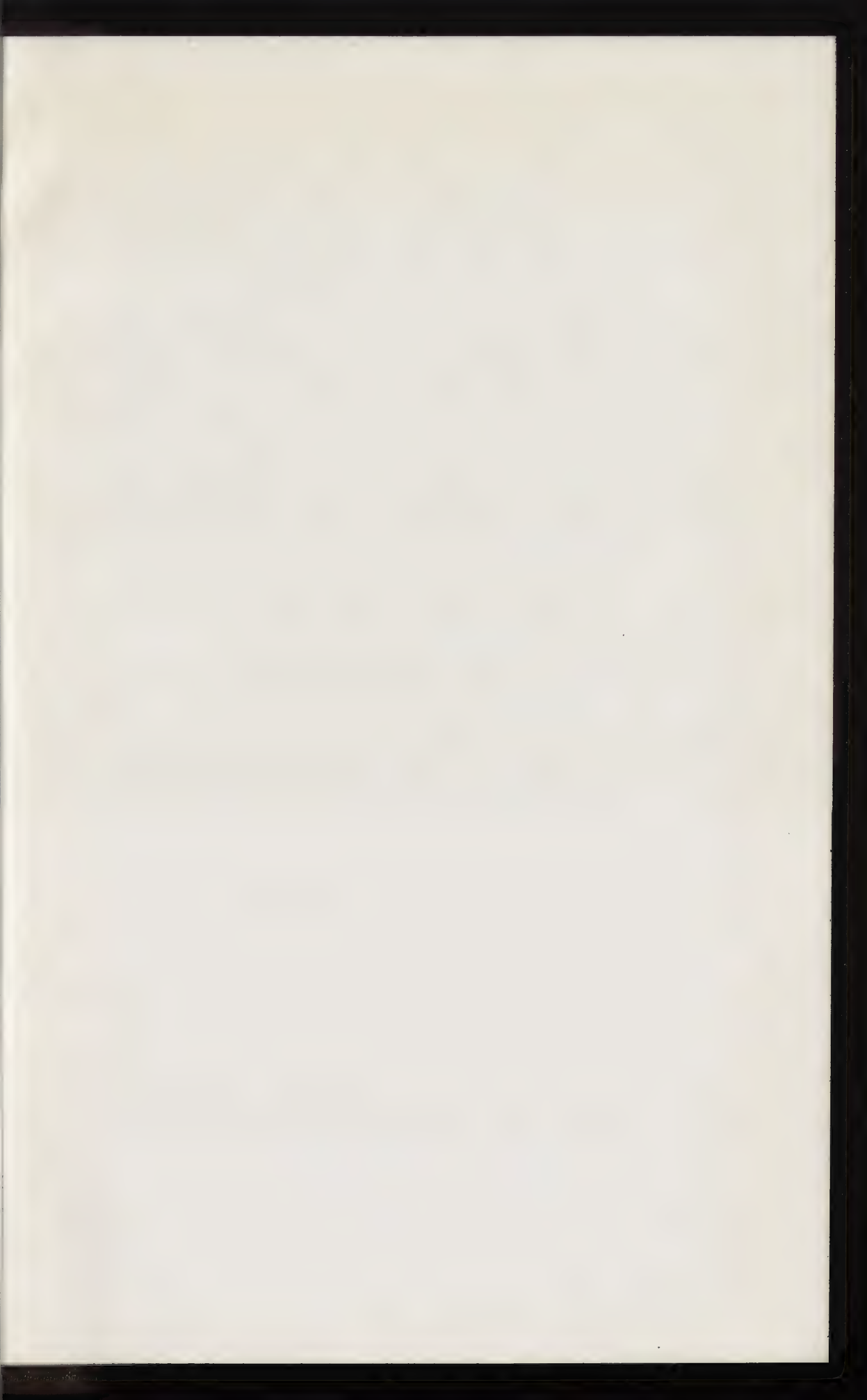
- Plate III, Vol. 3—*Pygathorix melan.*; s present in all upper incisors.
 " X, " "*Rhinopithecus roxell.*; trace in all upper incisors.
 " XIII, " "*Nasalis larv.*; trace in upper medians.
 " XVII, " "*Colobus satan.*; trace in upper medians.
 " XXIV, " "*Gorilla*; trace in upper medians.
 Extra Plate, pp. 106-7—*Rhinopithecus avunculus*; trace in upper medians.

AMERICAN MONKEYS. LEMURS.—Keilo-koilomorphy exist also in the American monkeys, but it is less typical as compared with man than in any of the preceding and more like the forms to be found in lemurs and related species. The tooth or its lower portion is partly to completely surrounded by a relatively narrow rim, which in extreme form may enclose the tooth surface as if in a shallow pit. The lingual fossa is as a rule not well marked, due to the preponderating development of the median ridge. The surface within the rim is often actually convex rather than concave, except along the borders where traces of a depression may be detected. A similar conformation may also occasionally be found in the Old World monkeys, and that even side by side with teeth that show a pronounced median depression. Thus in a Presbytes (142,205, U. S. National Museum), the lateral upper incisors are much like those of American monkeys, while the medians show marked rim as well as median fossa. In lemurs, recent and fossil we have really in general but rudiments of the rim and fossa formation, yet with a good glass its traces may be plainly detected.

Summarizing the results of the study of Primate teeth from those of anthropoid apes to those of the lemurs, it is evident that the rim and hollow formation of the incisors is a generalized condition throughout the order; that it occurs in various modified forms, the main modifying feature being the median lingual ridge; and that forms nearest to those of man are found not in the so far known anthropoid apes, but in some of the Old World monkeys.

MAMMALS OTHER THAN PRIMATES

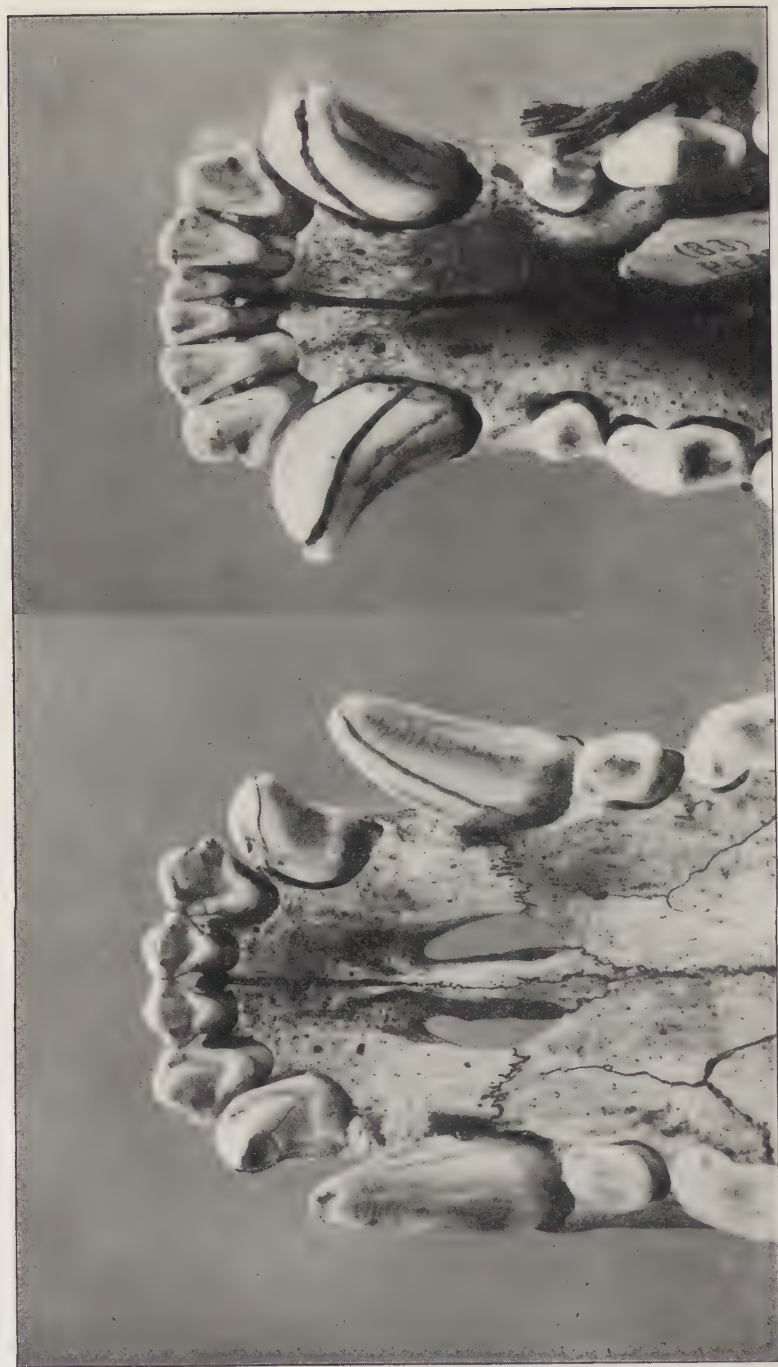
An extension of the study of the lingual surfaces of the incisors in different classes of lower mammals, soon showed that keilo-koilomorphy is present also in a more or less developed form among many of these, and that even where seemingly absent, it sometimes exists merely in a submerged or imperfect form. It may be traced in widely separated species and families, which merge into ancient extinct predecessors. Here then are morphological peculiarities of great antiquity, and that must have been possessed in their essentials by the common ancestors





Pl. V. Keilo-koilodonty, and Median Lingual Ridge, in Apes and Lower Mammals. Left: young Orang, 197,665; Middle: adolescent Orang, 142, 171; Right: Musk-ox, 120,921.





Pl. VI. Keilo-koilodonty on all Teeth of a Grey Wolf (*Canis* sp., 105,994, Idaho.)

of probably all terrestrial mammals, for there could hardly have been a separate development of such characters in the different orders and families.

Equally if not more ancient and significant, appears to be also the median lingual ridge, which in the lower mammals, as in the primates and occasionally in man, accompanies—or exists as a part of—the shovel-shaped formation (pls.V .VI.); but of this ridge more on another occasion.

A remarkable feature brought out by the examination of a large series of mammal crania in the U. S. National Museum is that modelings of incisors nearest to those of man are found not in the Carnivores, but in the Ungulates. The more primitive-like form of the carnivore teeth is not devoid of rudiments to marked traces of keilo-koilomorphy, but does not allow of a full development of these features.

Statistical determinations were again found impracticable, due to frequency of worn or otherwise affected teeth; but the following list will show the range of mammals in which the feature was detected:

KEILODONTY AND KOILOMORPHY IN MAMMALS BELOW PRIMATES

Carnivora:

218, 230		
105, 994.	<i>Ursus arctos</i>	Plainly marked fossæ, no rim.
	Other Carnivora	None to traces.
105, 994.	Grey Wolf	Marked traces on all incisors, also on canines and even on the premolars and molars (Pl. VI).

Ungulates:

	Calf, lower jaw, fig. in Kitt (Th.)—"Anomalien d. Zähne unserer Hausthiere," <i>Verh. d. d. Odont. Ges.</i> , 1892, III, 137.	Teeth remarkably akin to human in form; 8 lateral incisors (some supernumeraries) all more or less shovel-shaped.
218, 795.	<i>Alces</i>	All lower incisors shovel-shaped (w. median ridge).
102075.	<i>Alces Am.</i>	Marked traces.
113, 937.	" "	Traces to semi-shovel.
105, 100.	" "	All semi-shovel.
104, 532.	" <i>gig.</i>	Marked trace to semi-shovel.
35, 138.	" <i>mac.</i>	Trace.
113, 942.	" <i>sp.</i>	Semi-shovel to shovel.
120, 921.	Musk Ox	Marked Trace.
	Reindeer	Near shovel (a marked fossa on each side of the median ridge).

197, 136.	<i>Elaphurus dav.</i> (Chinese deer)	Deep fossa on each side of median ridge. <i>Note.</i> On medians the lateral borders have completely passed over the lateral fossæ and united with the median ridge, so that the worn tooth presents <i>two cavities</i> ; in laterals fossæ very deep, but still open. Additional little cusp on each of the first laterals (nearest medians) from the heel.
	Deer (various)	Traces.
	Gazelles	None to traces.
	<i>Antilocapra am.</i>	Approach.
182, 150.	<i>Oreotragus</i>	Medians shovel-shaped (well formed, in shape almost as in man).
153, 521.	<i>Ovis trag.</i>	Trace on all.
173, 817.	<i>Cobus el.</i>	Trace.
199, 703.	<i>Bubalus mindan.</i>	1, 2 or 3 fossæ next to ridges.
	Celebes buffalo (several)	Traces on most.
	Cow from Borneo	Small hollow on each side of ridge.
	American Bison	Small fossa on each side of median ridge.
151, 716.	Boar	Marked fossa on each side of median ridge (lower jaw).

CONCLUDING REMARKS

As so often happens, a beginning was made with an incidental noticing in a group of subjects of a feature that seemed to be of no particular significance, only to find on close attention a highly interesting morphological character, capable not only of giving valuable racial comparisons but in addition representing a most unsuspected biological distribution together with a great remoteness of origin. The whole study affords one of the clearest and most remarkable illustrations of the common origin of man with the rest of the mammals. It also demonstrates convincingly the wonderful persistence of structural characteristics of even secondary importance and in organs which have shown themselves to be susceptible of so much adaptation as the teeth. This recalls forcibly the conclusion of older authors that the teeth are at once the most plastic and the most conservative of structures.

The original call for the development of a rim and hollow on the lingual surface of the front teeth was in all probability a call for strengthening. An incisor of this form, all other things being equal,

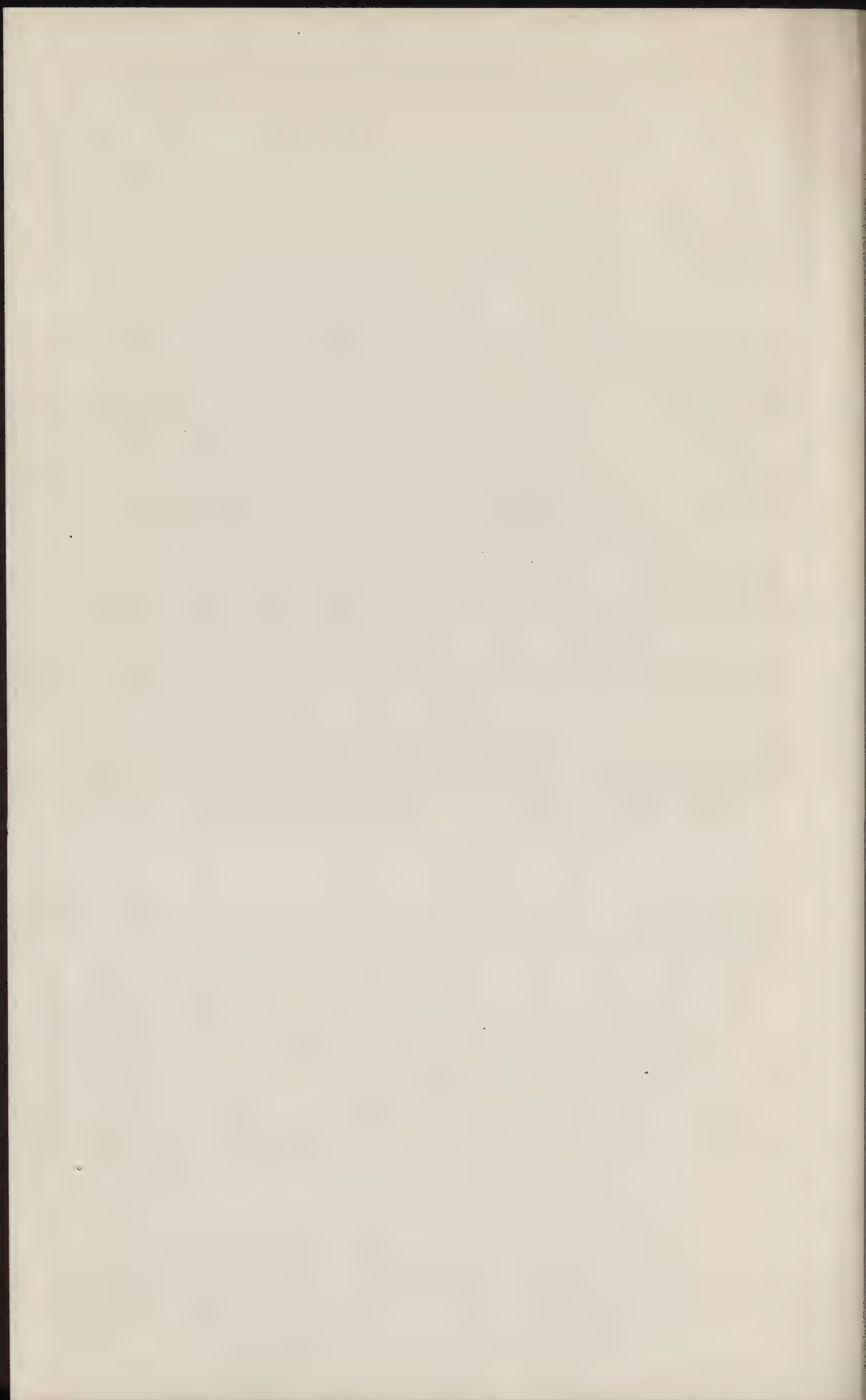
must on mechanical principles be considerably stronger than a flat-surfaced tooth.

If this hypothesis is true it may perhaps also explain why in the modern cultured white man and in such former relatively highly cultured branches of the white race as the Egyptians, the shovel-shaped feature, together with other characteristics of the lingual surface (the median ridge), has so largely disappeared. The teeth of these strains have unquestionably in general suffered weakening, due to less use.

According to this theory we should also expect to find a large proportion of shovel-shaped teeth in our early historic and prehistoric ancestors, with a gradually increasing proportion as we proceed backward, and so far the evidence seems to be in favor of this assumption. The great frequency of the condition in the present day yellow-brown peoples, may on the other hand probably be explained not so much by the greater call upon the teeth in these races as by a hereditary persistence from earlier times, together possibly with the play of selection.

The median lingual ridge (or ridges, for occasionally there may be two or even three) which so often, particularly in the Primates and lower mammals, accompanies the rim-and-hollow features of the lingual surface of the incisors, is a quite separate, and yet apparently functionally connected feature, which also tends to strengthen the teeth. More or less in evidence, it constitutes a strengthening element not merely of the incisors, but of every better developed cusp in the whole denture. It will be dealt with in a subsequent chapter.

The rim surrounding the fossa in shovel-shaped teeth is a composite structure, which as a whole does not appear to deserve to be regarded as the 'cingulum.' The basal part which represents the heel or tuberosity (*Tuberculum dentale*) and which may occasionally develop into an accessory cusp, is of a separate development to the *keilum* or rim proper, and may alone represent the cingulum of other teeth. However, this subject needs further investigation.



HEIGHT-WEIGHT INDEX OF BUILD

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In a recent publication (No. 272, Carnegie Institution of Washington, pp. 483-554) Professor C. R. Bardeen discusses the height-weight index of build in relation to linear and volumetric proportions and surface area of the body during post-natal development. In treating the height-weight index of build, he states: "The volumes of objects of the same shape but of different sizes vary as the cube of a given diameter through these objects. The volumes of the bodies of individuals of the same external form but of varying heights vary as the cube of the stature multiplied by a factor which is conditioned by the form of the body, as is conditioned by the form of a sphere. This factor, in the case of the relation of volume to stature, expresses the part of a space equal to the cube of the height occupied by the volume of the body. Thus, if we assume that 27c-inches is the volume of a pound, the volume of a man weighing 150 pounds would be 4050 cubic inches. If he were 68 inches tall the volume of his body would

occupy $\frac{4050}{314,432}$ of a space equal to the cube of his height or, expressed in terms of percentage, 1.288 per cent. The body of an individual 50 inches tall and of the same shape would occupy the same proportions of the cube of his height, or 1.288 per cent of 125,000, 1610 cubic inches. At 27 inches to the pound this would mean a weight of 59.6 pounds. . . . (p. 488-9).

"As a height-weight index in the study of stature, weight, and body form, we have adopted the weight of the body in pounds divided by the thousandth part of the cube of the height in inches (p. 489). . . . To reduce the inch-pound index to the centimeter-gram index, multiply the former by 0.02768. To change the centimeter-gram index to the inch-pound index either divide it by 0.02768 or multiply it by 36.13. Rohrer, in 1908, clearly pointed out the value of the quotient obtained by dividing the weight in grams $\times 100$ by the cube of the height in centimeters as an index of 'Körperfülle.'

Its value has been recognized by Martin in his *Anthropologie* (1914). It has, however, been but comparatively little used." So far Bardeen.

Despite the statistical argument for using the cube of height as a unit of measure of "build," "robustness," "Körperfülle," and despite the emphatic assertions of Martin (1914, p. 156) that this formula best represents the difference in the development of robustness, there are grave doubts as to the usefulness of this index.

During the past winter the writer has been engaged in analyzing an extensive series of measurements made on nearly 2,000,000 men, which includes, among others, weight and height. An analysis of the extensive tables seems to indicate that the normal changes in weight were accompanied by corresponding changes in height that were best compared with the square of the height rather than the cube. That is to say, for varying classes of weight and height the quotient obtained by dividing the weight by the square of the height gave more nearly a uniform quotient, strictly gave a smaller deviation from the modal ratio, than did either the ratio of weight to the cube of the height or weight to the first power of the height. The average deviation from the modal quotient was least when the square of the height was used, next larger when the cube of the height was used and largest when the first power of the height was used as a divisor.

The details of the above-mentioned procedure were as follows: A correlation table was used giving the relation of height to weight for 868,445 American men measured at the time of the Selective Draft. This is a table drawn up by the Surgeon General's Office, War Department, and not yet published. There were taken seventeen entries of varying height and weight with over 1000 individuals in each combination; the weight in each case was divided by the first, second, and third powers respectively of the height. The combinations are indicated in the following fractions, in which the numerator is the weight in pounds and the denominator the height in inches:

$$\frac{117}{63}, \frac{127}{63}, \frac{117}{65}, \frac{127}{65}, \frac{137}{65}, \frac{117}{67}, \frac{127}{67}, \frac{137}{67}, \frac{147}{67}, \frac{157}{67}, \frac{127}{69}, \frac{137}{69}, \frac{147}{69}, \frac{157}{69}, \frac{147}{71}, \frac{157}{71}$$

The quotient for the modal class of $\frac{137}{67}$ is, in the case of the 1st power of 67, 2.045; $100 \times$ the quotient obtained by using the 2d power as a divisor is 3.052; and $10,000 \times$ the quotient obtained by dividing 137 by the 3d power of 67, is 4.555. The deviation of each of the separate quotients was secured from 2.045, 3.052, and

4.555, respectively. This gives for the column of 1st power divisor the sum of the deviations, disregarding signs, as 2.587 which divided by 2.045, gives 1.265, the relative variability of the 16 group combinations, as obtained by using the first power of the height as a divisor. By using the 2d power of the height as a divisor the corresponding figure is 1.146, and by using the 3d power as a divisor it is 1.237. Hence, using the 2d power of the height for the outlying groups gives the smallest deviation from the condition found in the central or modal group.

Again, 5 extreme combinations were tested in relation of weight to height. These are as follows: $\frac{107}{61}$, $\frac{117}{61}$, $\frac{167}{73}$, $\frac{177}{73}$, $\frac{167}{75}$. Each of these combinations was found in several hundred individuals. Using the method employed for the 17 preceding combinations, we get an average relative deviation by using the first power of the height of .606; by using the 2d power, .230; by using the 3d power, .356. Thus, again, the 2d power gives the smallest average relative deviation from the modal combination of $\frac{137}{67}$. It appears that the use of the 2d power gives an average deviation that is under 50 per cent of that obtained by using the 1st power, and one which is much less than the relative deviation obtained by using the 3d power of the height.

TABLE 1

SHOWING (a) THE WEIGHT AND HEIGHT FOR WHICH THE HEIGHT-WEIGHT INDEX IS CALCULATED; (b) THE CORRESPONDING INDEX WHEN THE 1ST POWER OF HEIGHT IS USED (c) THE CORRESPONDING INDEX WHEN THE 2D POWER OF HEIGHT IS USED; (d) THE CORRESPONDING INDEX WHEN THE 3D POWER OF HEIGHT IS USED.

(a)	(b)	(c)	(d)
$\frac{117}{61}$, $\frac{117}{66}$, $\frac{117}{70}$	1.92 1.77 1.67	3.14 2.69 2.39	5.16 4.07 3.41
$\frac{127}{62}$, $\frac{127}{67}$, $\frac{127}{71}$	2.05 1.90 1.79	3.30 2.83 2.52	5.33 4.22 3.55
$\frac{137}{63}$, $\frac{137}{68}$, $\frac{137}{72}$	2.18 2.01 1.90	3.45 2.96 2.64	5.48 4.36 3.67
$\frac{147}{64}$, $\frac{147}{69}$, $\frac{147}{73}$	2.30 2.13 2.01	3.59 3.09 2.76	5.60 4.47 3.78
$\frac{157}{64}$, $\frac{157}{69}$, $\frac{157}{73}$	2.45 2.28 2.15	3.83 3.30 2.95	5.99 4.79 4.04
$\frac{167}{65}$, $\frac{167}{70}$, $\frac{167}{74}$	2.57 2.39 2.26	3.95 3.41 3.05	6.08 4.87 4.12

In additional respects the use of the 2d power as a divisor appears to give a better result than the use of the 2d or 3d power. As is well known, shorter men are more robust than tall men. By the use of the 1st power, the increase in robustness of abnormally short men over abnormally tall men is about 10 per cent; with the 2d power, it is about 30 per cent; with the 3d power it is about 50 per cent. It is quite clear that the shorter men are not 50 per cent more robust on the average than the tall men, though opinion may be divided as to whether a 30 per cent increase or a 10 per cent increase more nearly represent the general impression obtained by observing a number of men averaging 4 inches above the mean stature, as compared with a number of men averaging 5 inches below the mean stature. (Table 1.)

Were short people and tall people of the same shape, then it would be true that their weight would be expected to vary with the cube of any one dimension. But this assumption is not true. Were human bodies cylinders of the same diameter and of varying height, then it is clear that their variations in form would, be represented by variations in height alone. It is true that the human body, especially the trunk, approximates the condition of a cylinder whose vertical axis is more variable than the transverse axis.

Were human bodies cylinders of the same height but varying in transverse axis, then the differences in volume would be best indicated by the square of the transverse axis. The variations in robustness of persons of the same height are fairly accurately measured by the square of the transverse diameter or indeed of the chest circumference.

Were the human body a cube, sphere, or prism of constant proportions, then obviously the volume would vary as the cube of any one dimension. But this assumption is again only a rough approximation of the truth. As a matter of fact, the actual conditions are somewhere between that of a cylinder of constant diameter but of varying height and of a prism of constant proportions, and hence we may expect the proper denominator in the weight-height index to be between the first and the third power of the height. Empirically, the second power of the height proves most suitable.

Our empirical results are not new. On the occasion of the study by B. A. Gould, "Investigations in the Military and Anthropological Statistics on American Soldiers," 1869, especially on pp. 404-18, is found an illuminating discussion of the proportions of the body. In considering the relation between height and weight as derived from extensive tables of measurements taken of men at demobilization after the Civil war, he says, "We are irresistibly led to the singular

and interesting discovery that the mean weights, at least within the limits of the present researches, appear to vary strictly as the square of the statures." And again, "No reasonable doubt seems admissible that this is the true law of normal variation in weight for statures within our limits, and we are thus led to the inference that the product of the ratios of increase in the breadth and thickness of the body is, on the average, equal to the simple ratio of the increase in length."

But Gould goes further and has discovered that: "The fact here elicited had been observed by Quetelet who says that the weights of individuals of different heights who have attained their full development are approximately as the squares of their statures." Gould further points out that even during the period of growth subsequent to the age of 16 years, the increase in weight appears nearer to the second than to the $2\frac{1}{2}$ power of stature (proposed by Quetelet for the period of development), although when extended to the earliest years of life, it evidently requires modification. Gould indicates that this relation holds also for negroes and probably also for all races of men.

It is highly desirable to determine the law of relation of height to weight for the period of development from birth on. Quetelet (*Sur l'homme*, II, 53-61) says, "During the period of development the squares of the weights of different ages are as the 5th power of the stature." This conclusion he had obviously reached empirically. It is quite certain that Quetelet's empirical rule has a far better basis than the theoretical assumptions of Rohrer and Bardeen, and it is desirable to determine again on the basis of more extensive measurements, and by the method of Gould the proper relation between weight and stature in growing children. The final conclusion can, however, not be drawn until the quantitative series of index of build or robustness has been checked by the judgment as to relative "chubbiness" of a number of growing children.

As a contribution to this subject, there is given in the accompanying table a study of the relation of weight to stature based on the data obtained in Table A of Bardeen's paper. This table gives the weight and stature of male infants aged 1 to 30 months. In our table, we have taken the age in the odd months from 1 to 19, and then ages 20, 25, and 30 months. The corresponding weight in grams and the stature in centimeters are taken from Bardeen. In column 4 is given the ratio of weight to stature; in column 5, the ratio of weight to the square of stature; in column 6, Bardeen's index of build, which is the ratio of weight to the cube of stature expressed in English units

of measure. In Column 7 is given the results of dividing the weight by the height raised to the $2\frac{1}{2}$ power. A comparison of columns 4, 5,

TABLE A (FROM BARDEEN, TABLE A)

1	2	3	4	5	6	7
Age Months	Weight Grams	Height Centimeters	Weight Height	Weight Height ²	Weight Height ³ (Rohrer's Index)	Weight Height ^{2½}
1	3,451	50.6	68.201	1.3479	0.962	.18948
3	4,840	55.6	87.051	1.5657	1.017	.20997
5	5,868	60.5	96.991	1.6031	0.957	.20611
7	7,017	64.4	108.959	1.6919	0.949	.21083
9	7,579	67.4	112.448	1.6684	0.894	.20321
11	8,412	69.6	120.862	1.7365	0.901	.20815
13	8,479	70.7	119.929	1.6963	0.867	.20174
15	8,825	73.0	120.890	1.6560	0.820	.19382
17	9,810	76.0	129.079	1.6984	0.808	.19482
19	9,818	76.1	129.014	1.6954	0.805	.19434
20	9,973	77.5	128.684	1.6604	0.774	.18861
25	10,542	80.0	131.770	1.6472	0.744	.18416
30	11,407	83.7	136.284	1.6282	0.703	.17797

6, 7, reveals some interesting differences. In column 4 the index of build of the infant doubles from 1 month to 30 months. That is to say, that on the average children become twice as chubby at $2\frac{1}{2}$ years as they were at 1 month of age. This is manifestly not in accordance with experience. Column 5 shows an increase in chubbiness to the 11th month which is the age at which infants ordinarily begin to walk. There is then a decrease in chubbiness, with some irregularities in the course, to the 30th month and this decrease amounts to about 5 per cent. Rohrer's index, which Bardeen adopts, shows a decrease in chubbiness beginning after the 3d month and decreasing fairly regularly, the total decrease being to the 30th month about 30 per cent. This again does not seem to agree with common observation. One cannot say that on the average babies at $2\frac{1}{2}$ years have lost $\frac{1}{3}$ of the chubbiness that they had at 3 months. Column 7 shows an increase in chubbiness to the 7th month with a fairly high index of robustness at the 11th month, followed by a gradual decline to the 30th month. The falling off from the 11th to the 30th month is something over 10 per cent.

On the ground of common observation it would seem that the indices calculated in columns 4 and 6 must be rejected as not representing properly the state of affairs, but between columns 5 and 7 there is not a great deal of choice. A decision as to which of these is preferable would have been made by the opinion based on experience of mothers, child-welfare organizations, and possibly pediatricists. The

greater ease of calculating the indices of column 5 makes these indices preferable, other things being equal.

Table B is based upon Table E of Bardeen, which in turn is based on data from Quetelet, 1870, and gives the weight in kilos and stature

TABLE B (FROM BARDEEN, TABLE E)

1	2	3	4	5	6	7
Age Years	Weight Kilos	Height Centimeters	Weight Height	Weight ² Height	Weight ³ Height	Weight ^{2½} Height
Birth	3.1	50.0	62.00	1.2400	.2480	.17536
1	9.0	69.8	128.895	1.8473	.2646	.22111
2	11.0	79.1	139.064	1.7581	.2223	.19767
3	12.5	86.4	144.676	1.6744	.1938	.18015
4	14.0	92.7	151.024	1.6291	.1757	.16921
5	15.9	98.7	161.094	1.6322	.1654	.16429
6	17.8	104.6	170.172	1.6269	.1555	.15907
7	19.7	110.4	178.442	1.6163	.1464	.15383
8	21.6	116.2	185.886	1.5998	.1377	.14837
9	23.5	121.8	192.939	1.5841	.1301	.14353
10	25.2	127.3	197.957	1.5551	.1222	.13783
11	27.0	132.5	203.772	1.5379	.1161	.13360
12	29.0	137.5	210.909	1.5339	.1116	.13081
13	33.1	142.3	232.607	1.6346	.1149	.13703
14	37.1	146.9	242.552	1.7192	.1170	.14191
15	41.2	151.3	272.307	1.7998	.1190	.14632
16	45.4	155.4	292.149	1.8800	.1210	.15081
17	49.7	159.4	311.794	1.9561	.1227	.15493
18	53.9	163.0	330.675	2.0287	.1245	.15890
19	57.6	165.5	348.036	2.1030	.1271	.16347
20	59.5	167.0	356.287	2.1335	.1278	.16509
25	66.2	168.2	393.579	2.3400	.1391	.18042
30	66.1	168.2	392.052	2.3253	.1379	.17908

in grams from birth and at the end of each year subsequent up to 20 years, and also at 25 and 30 years. In this table column 4 gives the ratio of weight divided by stature. It will be seen that the index of build calculated in this way increases regularly from birth on and is over 6 times as great at 25 years as at birth. Obviously this ratio is not a good index of build. Column 5 gives the weight divided by the square of the stature. According to this index the baby at birth stands relatively low in chubbiness, has increased in this respect up to the end of the 1st year, and thereafter slowly declines in chubbiness to the 12th year. At the 25th year, the index of chubbiness or robustness is double that at birth and 50 per cent greater than at 12 years. This seems somewhat to exaggerate the extent of the filling out of the form from preadolescence to maturity and certainly to overweight the chubbiness or robustness of the average adult young man over that of the baby of one year. Column 6 gives Rohrer's index

for each year. This index increases from birth to one year and then diminishes gradually to 12 years of age, after which it increases to 25 years of age. The increase from 12 years to 25 is something over 20 per cent. The index for the adult (.14) is about half that of the child of one year (.26). This, I think, would strike the average observer as somewhat exaggerating the robustness or chubbiness of the infant. Column 7 gives the weight divided by the stature raised to the power $2\frac{1}{2}$, from Quetelet. Here we have a sharp increase in robustness from birth to one year, slightly declining to 12 years and then increasing to 25 years. The increase from 12 to 25 years is about 30 per cent. The robustness at 25 years is about 20 per cent less than at one year and corresponds rather closely with the child of 3 years. Owing to the circumstance that Quetelet's index does not show as great variations at the different ages as that of Rohrer or even that which involves the square of the stature, it seems probable that it accords more closely than either with the truth of the case in a developmental series, such as was considered in Table B. Also Quetelet's index brings out the proper relation between chubbiness of the

TABLE C. DEVIATIONS FROM 12-YEAR RATIO (BASED ON TABLE B).

	Weight Height	Weight ² Height ²	Weight ³ Height ³	Weight ^{2½} Height ^{2½}
12-yr. ratio	210.909	1.5339	.1116	.13081
Birth	148.909	.2939	.1364	.04455
1 yr.	82.014	.3134	.1530	.09030
2	71.845	.2242	.1107	.06686
3	66.233	.1405	.0822	.04934
4	59.885	.0952	.0641	.03840
5	49.815	.0983	.0538	.03348
6	40.737	.0930	.0439	.02826
7	32.567	.0724	.0348	.02362
8	25.023	.0659	.0261	.01756
9	17.970	.0502	.0185	.01272
10	12.952	.0212	.0106	.00702
11	6.137	.0040	.0045	.00279
12	0.000	.0000	.0000	.00000
13	21.698	.1007	.0033	.00622
14	31.643	.1853	.0054	.01110
15	61.398	.2659	.0074	.01551
16	81.240	.3461	.0094	.02000
17	100.885	.4222	.0111	.02412
18	119.766	.4948	.0129	.02809
19	137.127	.5691	.0155	.03266
20	145.378	.5996	.0162	.03428
25	182.670	.8061	.0175	.04961
30	181.143	.7914	.0263	.04827
Total dev.	1677.035	6.0534	.8636	.68476
Av. dev.	76.229	.2752	.03925	.03113
12-yr. ratio	.3614	.1794	.3517	.2379

infant of one year and the adult of 25 which is not properly brought out by using the square of the stature as a divisor.

Finally there is added in Table C, for comparison, the mean deviation of the indices in columns 4, 5, 6, and 7 for Table B. For the purpose of determining the average deviation the index at 12 years is taken as the basal line.

Table C shows that the average deviation from the 12-year ratio of the ratios obtained by dividing weight by 1st, 2d, 3d, and $2\frac{1}{2}$ th power of height respectively for each year prove to be smallest, on the average, when the 2d power is used as the divisor than when any other power is so used. The next smallest average deviation is found when the $2\frac{1}{2}$ th power is used as the divisor and next when the 3d power is used. The 1st power gives the largest average relative deviations. The conclusion from Table C then is that for the entire developmental series from birth to 30 years the ratio of weight to the 2d power of the height gives a better index of build than any other ratio.

To summarize, the best height-weight index of build is not the ratio of weight to the cube of height but some other ratio. For the first 30 months of development, it is doubtful whether the best index of build is that proposed by Quetelet (weight divided by height to the $2\frac{1}{2}$ th power) or the weight divided by the square of the height. The decision must rest on the agreement between the index and common observation as to "chubbiness." For the entire developmental series from birth to 30 years it is doubtful whether weight divided by the square or the $5/2$ d power of the height gives the most satisfactory index of build. But for young adult males the best index of build is apparently obtained by dividing weight by the square of stature.

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CONTOUR OF ORBITAL APERTURE IN REPRESENTATIVES OF MODERN AND FOSSIL HOMINIDÆ

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Broca¹ appears to have been one of the earliest observers to make a special study of the orbital aperture. To this eminent French observer, therefore, the initiation and exploitation of the orbital index are apparently due. He was soon followed by Sir Wm. Flower² who made very exhaustive observations on the orbital aperture amongst representative races of modern Hominidæ, as may be noted from the extensive tables compiled by him.

These two anthropologists were able to classify skulls into three groups according to the numerical values of their orbital indices. Since their time much controversy has been waged over the real value and significance of this index as a craniometric factor, and it is therefore important to mention the opinion of a great authority like Sir Wm. Turner³ who states that, "My observations on the orbital index in the skulls of numerous races have satisfied me that it presents a great range of variation in the same race, and that it possesses only a secondary value as a race character."

The writer's attention was first directed to a serious study of the orbital aperture in 1908 when engaged in the examination of two ancient Egyptian skeletons belonging to the XII Dynasty⁴. One of these skulls presented a very fine type with rounded orbital contours, while in the other case, which proved upon further investigation to have some degree of negroid admixture, the orbits were more quadrangular in shape, as is the general rule for the male cranium amongst the lowest races of modern Hominidæ. This observation therefore suggested that the orbital outline perhaps tended to be more rounded in character in the highest races of mankind, and quadrangular amongst the lowest racial types. The results of the present investi-

¹ Broca (P.)—*L'Indice Orbitaire*. Paris, 1876.

² Flower (W.)—*Catal. Mus. Roy. Coll. Surg.*, 2d ed., London, 1907.

³ Turner (W.)—*Trans. Roy. Soc. Edinb.*, 1903, XLI, 547-611.

⁴ Cameron (G.)—*Manchester Univ. Mus. Publ.*, 1910, LXVIII.

gation, however, show that the generalized form of orbital contour for the adult male skull in all modern races is the quadrangular, the variations of outline, both racial and sexual, depending upon the degree of "rounding off" of the four angles. In reference to this point the writer would like to state that, speaking generally, the four angles were found to be more rounded off in the higher or Eurasiatic races, than in the lower or Negro races of modern Hominidæ. This leads it should be emphasized, however, that the orbital contour was observed to be very variable even in individuals of the same race. Not only so, but further investigation showed that in the female, and in young persons of both sexes previous to adolescence, the contour was

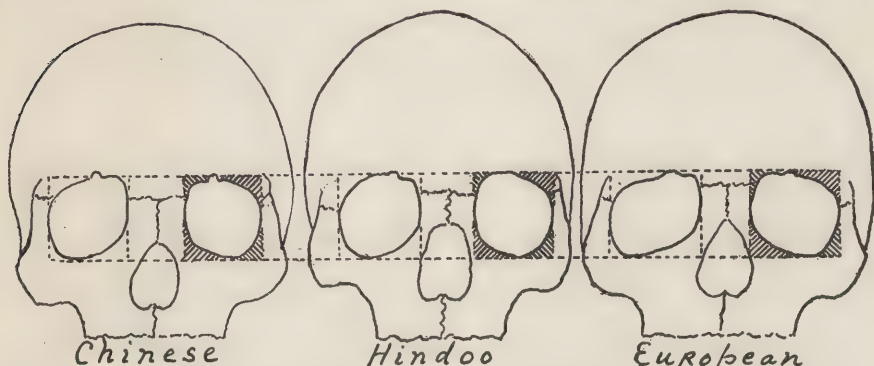


FIG. 1 represents three crania drawn to the same scale. The orbital apertures have been enclosed within rectangular areas in order to demonstrate the four "angles" of the orbital contour and the four "unoccupied spaces." It may be noted that the relative proportions of the latter agree fairly closely in the three crania.

different from that of the adult male of the same race. It therefore became clear that other factors besides race, namely sex and age, came into action, and exerted their influence so markedly in modelling the form of the orbital aperture, that it was finally decided to confine the present investigation solely to the adult male, and leave the study of the female and the younger generation to a subsequent occasion.

In Figs. 1, 2 and 3, are represented male crania belonging to nine races, very different and divergent in type. The crania were all drawn approximately to the same scale, and were traced from photographs. A base line was drawn through the lower orbital margins for each group of three. It was found impossible, however, to get one continuous line to pass along the upper orbital margins in each group of skulls, owing to the vagaries of their outlines, so that separate lines

had to be drawn for each skull or even for each orbit. The supra-orbital notch was not utilised as the uppermost limit of the supra-orbital border, owing to its inconstancy. Vertical lines were then drawn along the inner and outer orbital margins, the idea being to enclose the orbital aperture within a rectangular figure. This plan had the effect of intensifying the quadrangular outline of each orbit, which, as previously stated, was found to be the generalized form of aperture in these nine representative racial types.

Even a superficial inspection of the nine crania in Figs. 1, 2 and 3, discloses the fact that the Tasmanian orbital contour is different from all the others. Indeed, it was the detection of this difference

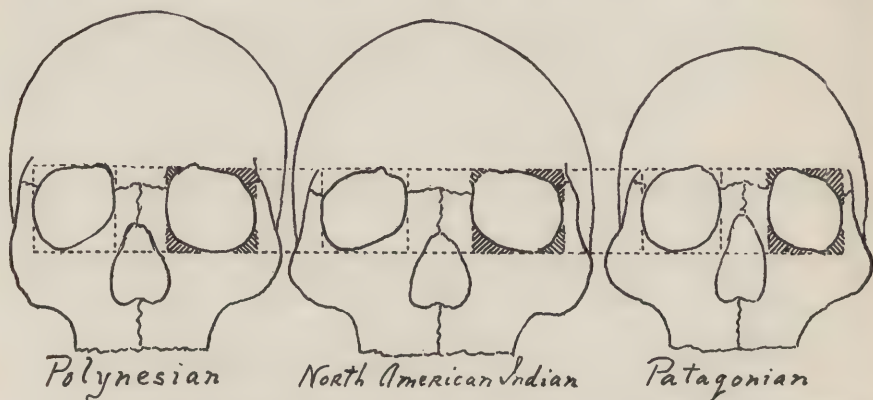


FIG. 2. Note how the positions of the four "angles," and how the relative proportions of the "unoccupied spaces" agree rather intimately in these three cranial types. Note also the high orbits and therefore the high orbital indices of these crania, and compare with the low orbits in Fig. 3.

in several Tasmanian crania that mainly inspired the production of this paper. It will be noted that the lines of maximum width of the Tasmanian orbital contours lie practically in the same *horizontal* plane, the result being that their four rounded angles fit into the four corners of the dotted rectangle in a rather remarkable way.¹ Moreover, it may be further observed that the outer and inner, but particularly the lower margins of the Tasmanian orbital aperture, coincide to a considerable extent with the corresponding margins of the dotted rectangle.

The manner in which the orbital contours are orientated within

¹ The author has yet to satisfy himself as to whether this is a special feature of the aboriginal Tasmanian cranium.

the dotted rectangle in the case of the other eight crania, represented in Figs. 1, 2 and 3, exhibits on the other hand, a striking contrast to the above. Owing to the obliquity of the lines of maximum width in these, the contours are observed to be in contact with the sides of the dotted rectangle at four main points which are to be regarded as the rounded "angles" of the quadrangular type of orbital aperture. On examining these eight crania it will be seen that the positions of these rounded angles exhibit some degree of constancy. For example, in those skulls where the supero-internal "angles" are in contact with the upper sides of the dotted rectangle, the points of contact are approximately at the junction of the inner $\frac{1}{3}$ or so with the outer

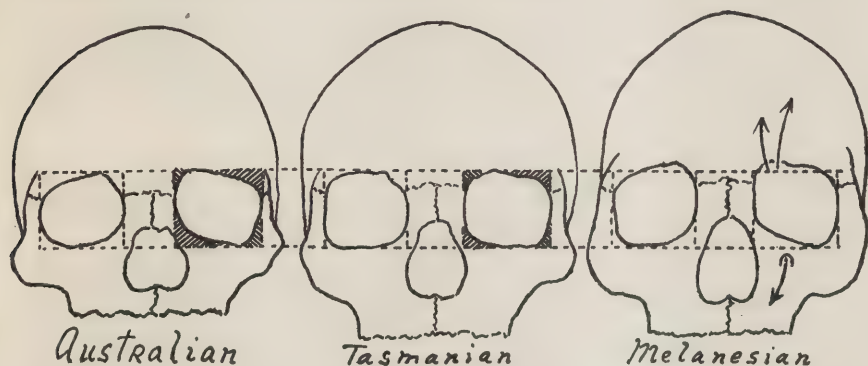


FIG. 3 displays three crania belonging to the negro races. Note that the lines of maximum width of the Tasmanian orbits lie practically in the same horizontal plane, thus reducing the "unoccupied spaces" of the rectangles to a minimum. For comparison study the obliquity of the orbits in the other two crania.

2/3. The infero-internal "angles" touch the inner sides of the dotted rectangles at about their centres or perhaps a little lower. The infero-external "angles" have their points of contact about the junctions of the inner $\frac{2}{3}$ and outer third of the lower sides of the dotted rectangles, while the supero-external "angles" touch the outer sides of the dotted rectangle at about their centres or perhaps a little higher. It may be noted therefore that this plan yielded some rather interesting results.

On studying next the amount of space left unoccupied between the orbital contour and the angles of the dotted rectangle, it was again ascertained that there were some facts bearing a fair degree of constancy and consistency towards each other. Upon examining the tracing of the European type of skull shown in Fig. 1, it will be seen

that these unoccupied spaces have been shaded in the left halves of the Figs. in order to define their surface areas more effectively. A study of these "unoccupied spaces" in Figs. 1, 2 and 3, will demonstrate the fact that the infero-internal space is as a rule the largest, with the supero-external a close second. The infero-external space is the third largest, while the supero-internal space is decidedly the smallest. It was therefore clear as this research progressed that many facts of more than passing interest manifested themselves.

The next question to be decided was the causation of this generalised quadrangular form of orbital contour. After a careful consideration of all the facts it was ascertained that these causes came under the following headings:

1. Influence of the developing frontal and maxillary air sinuses.
2. Resistance exerted by the perivascular fascia of blood vessels and nerves.
3. Traction exerted by muscles.
4. Growth and expansion of the Brain.

Of these causes it was found that (1) and (2) acted simultaneously, while (3) and (4) exerted their own independent actions.

After a close examination of the interiors of the frontal and maxillary air sinuses in many skulls, representing the various racial types of modern hominidæ and also in the skulls of certain of the anthropoid apes, the author was able to detect numerous proofs of the action exerted by the development of these cavities on the contour of the orbital aperture. For example he was much impressed by the appearance presented by the floors of the frontal sinuses in a European type of skull, the interior of the left one represented in Fig. 4.

Extending forward on the floors of these sinuses, which it may be stated were abnormally large, two divergent ridges could be detected. I could find no previous record of the existence of these ridges in textbooks of Anatomy. They were each 12.5 mm. in length and faded away above the site of the supraorbital border exactly at the points where the supraorbital and supratrochlear nerves swept round that border. The outer ridge therefore ended immediately above the site of the supraorbital notch. Similarly, the anterior end of the inner ridge indicated accurately where the supratrochlear nerve with its accompanying vessels had swept round the bone onto the forehead in this individual. It is important to note that there were no grooves corresponding to these ridges on the anterior part of the orbital roof. On the posterior part of this roof, however, close to the

sphenoidal fissure, was a well marked groove, 13 mm. in length, for the reception of the frontal nerve. An examination of this bone specimen thus yielded us quite a fund of information regarding the anatomy of the adjoining soft tissues, for the divergent ridges provided a vivid mental picture of the bifurcation of the frontal nerve into its resultant branches. Moreover, it demonstrated also the fact that the tension on the frontal nerve trunk during the development of the frontal sinuses caused its posterior end to become actually impressed into a groove in the orbital plate of the growing frontal bone. I can

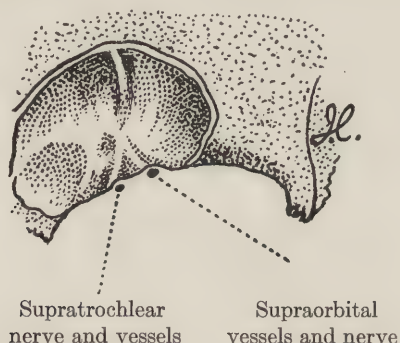


FIG. 4 exhibits a frontal sinus of the left side, the anterior wall of which has been removed in order to expose its cavity. The positions where the supraorbital and supratrochlear nerves with their accompanying vessels sweep round the supraorbital margin are indicated. The appearance presented by the cavity of this sinus suggests that during its expansion it had become bent over the above vessels and nerves, which acted as the fulcrum. This impression was corroborated by the presence of two divergent lines of "strain" on the floor and a prominent "line of strain" on the roof of this sinus. The author can find no evidence of the existence of these ridges having been previously recorded.

find no previous reference to the existence of this groove on the orbital roof. It certainly can be detected in a large proportion of crania if looked for, and it is frequently accompanied by a parallel groove for the reception of the accompanying supraorbital vessels.

A further examination of this remarkable frontal sinus revealed another interesting feature in the shape of a falciform buttress of bone projecting down into the cavity from the roof to the extent of 4 mm., at its center. This lay in an antero-posterior direction immediately above the ridge on the floor that presented the line of the supraorbital vessels and nerve, and terminated about half way down the anterior and posterior walls (see Fig. 4). It is thus quite clear

that the divergent ridges on the floor of the sinus represented "lines of stress" which compelled nature to furnish protective bastions in these situations. The buttress on the roof however suggested something further than this, and the best term I coin to describe this is a "ring of stress." It is thus quite apparent by this time what happened in this case, since all the evidence indicated that the expanding frontal sinus became bent downwards over the terminal branches of the frontal nerve, and this was exactly the appearance presented by the cavity; for the outer portion of the floor formed an angle of about 150° with the inner portion. The expanding frontal pole of the brain probably facilitated matters in this direction by exerting some degree of pressure or, at any rate, resistance from above.

Infraorbital canal containing the vessels and nerve in their sheaths.



FIG. 5 is a sketch of the anterior wall of a specially large maxillary sinus of the left side. Note the presence of prominent ridges and marked groins due to the resistance of the superior dental vessels and nerves to the expansion of the sinus. A feature of this sinus was the depth of the recess (marked *R*) the lower boundary of which was a well defined ridge containing the branches from the anterior superior dental vessels and nerve that supply the outer wall of the nasal fossa. So far as the author can ascertain, the existence and causation of this ridge do not appear to have been previously recorded.

The genesis of the supero-internal angle of the orbital aperture now becomes readily understood and appreciated; for it is produced in great measure by the frontal sinus, and therefore also the underlying supraorbital border, becoming bent over the terminal branches of the frontal nerves and their accompanying blood vessels, which form the fulcrum, as indicated by the arrows in the melanesian skull in Fig. 3. Owing to the fulcrum being situated nearer to the inner end

of the supraorbital margin the outer portion of this is most affected, and tends to become flattened out, as indicated in the skulls shown in Fig. 1, 2 and 3. Compare this condition with the rounded supraorbital margin of a young adolescent as represented in the cranium of the Grimaldi Youth (Fig. 6). The strain is evidently greatest on the supraorbital vessels and nerves, which as a result literally cut their way deeply into the bone, thus producing the supraorbital notch. Moreover if osteoblastic activity be well marked in this region a supraorbital foramen is the result, in which case the supero-internal angle of the orbital aperture becomes more pronounced, and at the same time more definitely located, at the point where the supratroch-

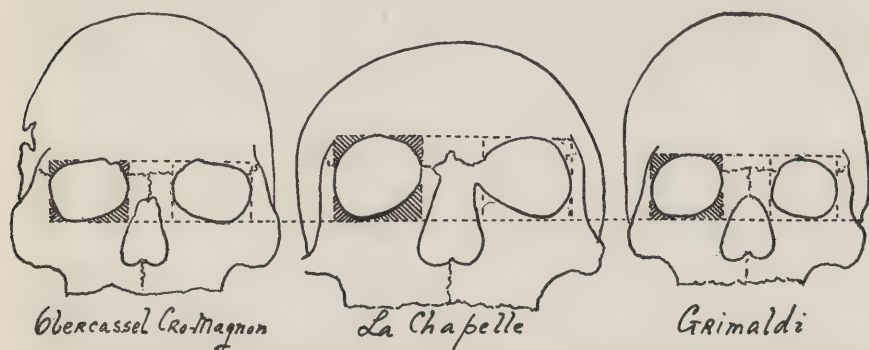


FIG. 6 exhibits three crania of fossil Hominidæ. The Cro-Magnon type shows the quadrangular form of orbital contour in a marked degree, while the Grimaldi cranium displays the rounded contour found in adolescents. The triangular outline of the orbits in the La Chapelle skull is very peculiar, and does not conform to the average modern contour. These three crania were traced from photographic reproductions in the *Memoirs of Bonnet, Boule and Verneau*, the use of which is hereby acknowledged. These crania are not drawn to the same scale.

lear nerve sweeps round the bone margin. In this relation the aboriginal Australian frontal bone described by Cunningham (*Trans. Royal Soc. Edin.*, Vol. 46, Pt. 2) is worthy of study, for the traction upon the supratrochlear vessels and their accompanying blood vessels had been so great in this specimen, that these structures had become deeply sunk in well marked grooves which had pinched off the inter-orbital portion of the bone to a slight degree. Moreover, it should be further noted that in the Neanderthal calvaria the supratrochlear nerve and its accompanying vessels had traversed a foramen on both sides, showing that these structures could likewise cut their

way deeply into the supraorbital margin. This is, however, a very exceptional condition.¹

Various signs of the existence of the tension on the above nerves have just been indicated. Another very important one has again to be recorded in the shape of the well-marked branching groove I have previously described on the under aspect of the orbital plate of the frontal bone into which the taut vessels and nerves become pressed. This leads me to refer to the fact that a careful dissection of the latter structures shows that they are all intimately bound together in a tissue that I have previously termed the perivascular fascia (in a paper on the pelvic fascia² that appeared 13 years ago). It is therefore not so much a question of traction upon the nerve fibers alone, as upon this general perivascular fascia and on its innumerable ramifications and attachments to the subcutaneous fascia along the ultimate distribution of these vessels and nerves over the frontal region of the scalp.

On investigating the Anatomy of the maxillary sinus along lines similar to those adopted in the case of the frontal sinus, several signs of traction upon the perivascular sheaths of certain neighbouring vessels and nerves likewise became manifest. Some of these manifestations are indicated in Fig. 5, which is a drawing of the front wall of an unusually large maxillary sinus, of the left side, studied from the interior. In this specimen a strong buttress of bone extended downwards from the front end of the infraorbital canal, and was so prominent that it projected backwards into the cavity of the sinus to the extent of 9.5 mm. at its upper end. This almost immediately bifurcated into outer and inner branches, of which the outer conveyed the middle superior dental nerve, while the inner transmitted the anterior superior dental vessels and nerve to their distribution. The "groining" of the sinus wall between all these ridges was very pronounced.

On studying the inner ridge it was found to divide again into two, one branch containing the vessel and nerve to the front teeth, while the other curved inward toward the outer wall of the nasal fossa (Fig. 5). A more intimate examination of the latter elicited the interesting fact that it represented the line of the canal which conveys the minute twig of the anterior superior dental nerve that supplies the outer wall of the nasal fossa. By the way I have been unable to find any reference in textbooks to the existence of this ridge, which

¹ Schwalbe (G.)—*Der Neandertalschädel*. *Bonner Jahrb.*, 1901, CVI.

² Cameron (J.)—*J. Anat.*, 1907, XLII, 112-125.

undoubtedly can be detected in a large proportion of cases. Fig. 5 shows that it forms the lower boundary of a well-marked recess (*R*) which in this specimen was 9 mm., in depth at its center while its oval opening measured 19 mm., in height and 9 mm., in width.

On opening up the infraorbital, the middle superior dental and the anterior superior dental canals in a fresh dissection, it will be noted that on removing the bony wall, their periosteal lining remains *in situ* as a tubular sheath to the canal, the vessels and the nerves, being intimately adherent to these through their perivascular sheaths. If these tubular sheaths be pulled upon, it will be observed that they display a considerable degree of toughness and strength, and could therefore offer an appreciable amount of resistance during the expansion of the cavity of the maxillary sinus in early life. Fig. 5 exhibits signs of this resistance which was clearly instrumental in producing the strong buttresses already described as projecting markedly into the sinus cavity. The actual specimen showed even secondary "groining" on the bone, branching off between the main projections, and all indicating "lines of strain" just as in the case of the frontal sinus.

A study of the mode of development of the infraorbital canal likewise added further testimony to the existence of this traction on the perivascular sheaths of the corresponding vessels and nerve. In the early developmental stages, as is well known, the latter structures are exposed on the orbital floor, but as the maxillary antrum expands they become buried deeper and deeper in the infraorbital border just as in the case of the supraorbital vessels and nerve, only the action is always more pronounced in this case. The result is of course the production of the infraorbital canal and foramen. The arrow that is shown directed downwards and inwards in the Melanesian cranium in Fig. 3, indicates the direction of the traction, and also the upward pressure of the expanding maxillary antrum, the combined result of which is to flatten the lower orbital margin, and at the same time drag it downwards and inwards, thus producing the infero-external and infero-internal angles of the orbital contour, which are a fairly well marked feature in the crania represented in Figs. 1, 2 and 3.

The supero-external and infero-internal angles of the quadrangular orbital contour are not usually so apparent, but their production is the sequel of that of the previous two, and they have been already indicated in the crania exhibited in Figs. 1, 2 and 3. The crania exhibited in these figs. certainly suggest that the outer portions of the

orbital apertures have been deliberately pulled bodily downwards, and this effect is rendered more convincing if these orbital contours be compared with those of the Grimaldi youth shown in Fig. 6. The latter, it may be noted, still exhibit the rounded outline of early adolescence, and contrast markedly with the fully mature adult condition manifested by all the others. This traction on the outer portions of the orbital aperture is probably assisted by the action of the muscles of mastication, particularly the masseter and temporal which by their powerful contraction must exert a considerable downward pull upon the zygomatic arch and the bones of the temporal fossa of the young growing skull. These bones it may be noted are in more or less intimate structural continuity with the outer orbital wall, and must exert a certain amount of indirect traction upon that also. This may partly explain the marked quadrangular outline of the orbital aperture in the negro races, for it is a well-recognized fact that the muscles of mastication are very powerfully developed in some of these lower types of modern hominidæ.

A study of the orbital contour in certain types of fossil hominidæ was found to yield some points of interest. The Obercassel Cromagnon male skull, the La Chapelle male skull, and the cranium of the Grimaldi youth, were chosen as representing three very divergent types, and these are exhibited in Fig. 6.¹ The orbital apertures of the Obercassel cranium are seen to present the generalised quadrangular contour in a marked degree, the lines of maximum orbital width being placed very obliquely as in the lower types of modern Hominidæ. This is important in view of the statement at the end of the preceding paragraph; for the zygomatic arches and jaws of this cranium were very strongly developed, thus suggesting indirect traction by massively developed muscles of mastication on the outer boundaries of the orbital apertures.

The contour of the orbital apertures in the La Chapelle cranium was found to present very distinctive features. The lower margins, as seen in Fig. 6, exhibit oblique flattened outlines, the result being that there are unusually large wide spaces between them and the infero-internal angles of the dotted rectangles. The general effect thus produced is a somewhat triangular orbital contour, this appearance being exaggerated by the deficiency in the inner margin of the left orbit. I have certainly been unable to discover a modern type

¹ These crania are not represented on the same scale.

of cranium with orbital contours at all comparable to those of the La Chapelle cranium.¹

The Grimaldi cranium is of special interest in reference to the present investigation for it provides a means of comparing the orbital contour of the early adolescent male type with that of the adult male type of skull. This fact is merely mentioned in passing, as the orbital aperture in the female sex and in childhood is to form the subject of a future study, as previously remarked. However, the observer's attention may be directed at this stage without impropriety to the fact that the orbital apertures in the Grimaldi youth are seen in Fig. 6 to be rounded in character with a relatively high orbital index, and in fact conform to the adult female type, a condition found to be the general rule in early adolescents of both sexes.

MAIN CONCLUSIONS

The generalized form of orbital aperture in the adult male skull of modern races is represented by a quadrangular contour, individual variations of outline depending upon the degree of "rounding off" of the four "angles."

If the orbital apertures be enclosed in a rectangular figure with horizontal and vertical sides, it will be found that the four "angles" of the quadrangular orbital contour are in contact with the sides of this rectangle at fairly well defined points.

The surface areas of the "unoccupied spaces" between the orbital contour and the angles of the rectangular figure are capable of some degree of comparison in different crania.

The main factors in the production of the quadrangular form of orbital aperture are as follows:

- (a) Influence of the developing frontal and maxillary air sinuses;
- (b) Resistance exerted by the perivascular fascia of the neighboring blood vessels and nerves;
- (c) Traction exerted by muscles;
- (d) Growth and expansion of the brain.

In a large proportion of crania projecting buttresses of bone can be found in certain definite sites inside the frontal and maxillary air sinuses, indicating "lines of stress" in these cavities produced by the resistance of the "perivascular fascia" of neighboring blood vessels and nerves to the expansion of these cavities. No previous record of these ridges has been found by the author.

¹ See papers on this subject by the writer in *The Canadian Magazine*, Oct., 1917, and *Trans. of the Royal Society of Canada*, Vol. XII, Series 3, 1918.

The supero-internal "angle" of the quadrangular orbital contour is produced in great measure by the frontal sinus (and therefore also the supra-orbital border) becoming bent over the terminal branches of the frontal nerve and their accompanying blood vessels and perivascular fascia which form the fulcrum.

The resistance offered by the perivascular fascia of the supra-orbital vessels and nerve to the expansion of the frontal air sinus in a downward direction is evidenced by the production of the supra-orbital notch and of an occasional groove on the posterior part of the orbital roof, the existence and causation of which do not appear to have been previously recorded.

The buttresses of bone thrown out as a result of the resistance of the perivascular fascia surrounding the blood vessels and nerves in close relation to the maxillary sinus, are frequently very pronounced and complex.

The infra-orbital canal is produced by the resistance of its contents to the upward expansion of the maxillary sinus, thus causing the vessels and nerve with their pervascular fascia to become buried deeper and deeper in the growing bone, and at the same time flattening out the lower orbital margin, the result of which is to produce the infero-external and infero-internal angles of the orbital aperture.

A study of the orbital contour in lower forms of modern Hominidæ and in certain types of fossil Hominidæ suggests that the downward traction exerted on the outer portions of the orbital aperture is probably assisted by the action of the muscles of mastication, particularly the masseter and temporal.

SPECIAL COMMUNICATIONS

ARTIFICIAL DEFORMATIONS IN HAWAII

JOHN G. STOKES

Curator of Ethnology, Bernice Pauahi Bishop Museum, Honolulu

Dr. Hrdlička.—In regard to your enquiry concerning physical deformations of Hawaiians by artificial means—I include below the partial information I have gathered so far.

Head Moulding.—My attention was first called to the subject by Professor J. Macmillan Brown, who referred to the term “opa” in Andrews’ Hawaiian Dictionary as indicating “to press; squeeze, as the head of a child.” Dr. Brown obtained some information from a long-time white resident here, which showed that head-moulding was probably a Hawaiian custom, and asked me to make further enquiries.

Many Hawaiians have since been questioned with respect to the term and custom, but the enquiries have by no means been concluded. The following notes may therefore be subjected to a later revision.

Term Used.—I could not learn what term, if any, was used for the process. *Opa* indicates the manipulative pressure between palm and fingers in massage, and is sometimes used in place of *lomilomi* (massage). It has no particular application to head-moulding. One Hawaiian woman suggested that the term sought was *opaha* (to be bent in, as the roof of a grass house partly fallen in—Andrews). Later information, however, was to the effect that *opaha* was applied in the description of a child’s head when lop-sided as a result of the mother’s holding it, during nursing, too continuously on one side. It is possible that there was no special term for the process, and the general term *hooponopono* (to make correct) served the purpose. *Poo pakiiki* (broad head) described a head when suitably flattened at the back and rounded, and indicated proper parental care. *Poo puu* (lumpy head) was a head with a posterior projection—evidence of neglect during infancy. A high forehead was considered ugly.

Andrews referred to “Anatomia” (Mission Press, Oahu, 1838) as authority for the term *opa*. This little book, without designated author, was “written in Hawaiian for the instruction of the pupils of Lahaina-

luna School in anatomy" as the Hawaiian title page intimates. As may be assumed by the wording of the text, it was prepared by the missionary teachers and not by Hawaiians. I translate, as literally as possible, the passage in this work relating to head-moulding:

In unenlightened countries the people regarded as a matter of importance the changing of the natural form of their children's heads into new shapes. Some pressed (*opa*) on the sides of the head to flatten them. Other people manipulated the forehead. The people of Hawaii regarded as the ideal head one which was flattened on the forehead and behind. In enlightened countries the people allowed the heads of their children to remain in the beautiful form in which God made them.

Process Followed.—Enquiries resulted in ascertaining that knowledge of the custom had not been lost, although few Hawaiians were acquainted with the methods. Accounts furnished last year by three women in Kona, island of Hawaii, differ in detail. Those of the first two were not repeated by other Hawaiians, but I believe are to be trusted. The third account was most frequently met with and has since been generally confirmed on Oahu. With all three, operations were said to have begun as soon as the baby was born.

The first woman, sixty-five years old, said that the infant was placed on its back with the head resting on a portion of coconut husk lined with pulu (the soft silky fiber of the tree-fern). In this position the forehead was frequently pressed downward with the palm of the hand. It was stated that the treatment continued for a week or two until the bones hardened.

The second woman, about forty-five years old, described a binding process. Two portions of the hard shell of the coconut were lined with pulu and bound over the baby's head—one at the forehead and the other at the back. They were removed whenever the child was bathed (once or twice a day), and the head carefully massaged to keep up the circulation. The time required was as in the preceding account.

The third, a grandmother over sixty years of age, stated that the baby was carefully laid with the back of the head resting on a piece of gourd lined with soft tapa, and kept in that position. The forehead was not touched, nor any shaping at all done by the hands. The treatment continued for a week. This woman pointed out a middle-aged man (with decidedly negroid hair) as one whose head had been re-shaped by this means. The man's forehead was high and gave no indication of having been moulded artificially, but the back of his head was almost flat in a vertical line. His head seemed rounded and higher than those of his Hawaiian neighbors.

The three women referred to were the only persons encountered who appeared to be well acquainted with the process. Other accounts from men and women varied the time required from a week to three months, and, in general, these informants described the same treatment mentioned by the third woman. The moulded head was said to have been the form admired by the chiefs.

The custom fell into disuse some years ago, its initial breaking down being probably due to missionary teaching. (See above.) Its final abandonment, however, was hastened and without doubt accomplished by the resentment of the growing youth who found difficulty in wearing the imported hats. The latter explanation was furnished by one of my elderly informants. It is not improbable that manipulation ceased under missionary instruction or injunction and with it the moulding of the forehead. However the mothers, generally conservative, were able to keep up the practice in a certain degree by keeping the infant lying on its back, and thus attained their object without apparent conflict with the ideas of their new spiritual advisers.

These remarks, of course, cannot be considered conclusive at the present stage of investigation.

Finger and Body Moulding.—In addition to head-moulding, the bodies of female infants had to undergo further modification in order to make them grow up beautiful in Hawaiian eyes. While the head was being re-shaped, the fingers were tapered by squeezing and rolling. The process was called *omilo* (to roll or twist), a general term. The arms and legs were massaged in order to enlarge certain portions and diminish others, as a fat limb with appropriate dimples was a thing of beauty. The trunk was also massaged. It is difficult to-day to ascertain how long these manipulations continued, and to what extent they were carried out,—finger-moulding alone excepted.

RACE MIXTURE IN HAWAII¹

The Hawaiian Islands are remarkable for the diversity of races represented and for the varied conjugal race-mingling which has taken place in this tiny island world during the past hundred and fifty years.

In 1918, the population of Hawaii in round numbers was as follows:

Asiatics.....	153,500
Japanese.....	105,000
Chinese.....	23,000
Koreans.....	5,000
Filipinos.....	20,000
Polynesians.....	40,000
Hawaiians.....	23,000
Caucasian-Hawaiians.....	11,000
Chinese-Hawaiians.....	6,000
Latins.....	31,000
Portuguese.....	23,000
Spanish.....	2,000
Porto Ricans.....	6,000
Americans, Scotch, British, Germans, Russians, etc.....	22,000

The Chinese began to come to Hawaii in 1870. At present over half the Chinese men marry Chinese women, while most Chinese women marry Chinese men. A large percentage of the Chinese men marry Hawaiian or part-Hawaiian women. Very few Chinese women marry Hawaiian or part-Hawaiian men. Only one Chinese man has married an American woman; a few Chinese women have been married by American men. An appreciable amount of mingling has taken place between the Chinese and the Portuguese; Chinese and Chinese-Hawaiian men marry Portuguese, Spanish, Hawaiian, Caucasian-Hawaiian, etc. The most significant feature is the large number of mixed marriages, in which the Chinese, Hawaiian, and Caucasian-strains intermingle.

Japanese immigration began in 1886, that of Koreans about 1900. In general, Japanese marry only Japanese; they show remarkable racial aloofness, more so, as a race, than any other in Hawaii. A few Japanese men have married Hawaiian, part-Hawaiian, and Portuguese women; only one has married an American woman. There are surprising few marriages between the Japanese and the other Asiatic

¹ MacCaughey (V.)—*J. Hered.*, 1919, X, 41-47.

peoples in Hawaii; a few Japanese women have been married by Chinese and Koreans.

All the Korean women have married only Koreans. The Korean men have married not only Koreans but also women of Hawaiian and part-Hawaiian blood.

The Japanese and Koreans contrast strongly with the Chinese in race mixtures, the former groups evincing strong clannishness in marital selections; the latter groups freely breeding "out." In general, Asiatics in Hawaii breed more freely with Caucasian stock than they do among themselves.

The majority of Portuguese men marry Portuguese. Their national preferences, outside their own group, in quantitative sequence are: Hawaiian, Caucasian-Hawaiian, Spanish, Chinese-Hawaiian.

Most Spanish men married Spanish women. Spanish women marry freely outside their nationality. A small amount of intermarrying takes place between Spanish and Portuguese. A notable number of Spanish women are married by Porto Ricans and Filipinos. The intermarrying between Spanish and Hawaiian and part-Hawaiians is very slight, especially when contrasted with the Portuguese in this regard.

Most Hawaiian men marry Hawaiians. Hawaiian women marry freely outside their own race. Notable among the racial preferences of Hawaiian men are their marriages with Caucasian-Hawaiians, Chinese-Hawaiians, and Portuguese.

Only one half of the American men married Americans; most of the American women married Americans. In numerical order, American men married Americans, Portuguese, Caucasian-Hawaiians, Hawaiians, British, German, Chinese-Hawaiians, and Porto Ricans. Only 13 American men and 3 American women married Asiatics; 15 American men married Chinese-Hawaiians; 223 married women of Hawaiian or part-Hawaiian blood. The 116 American women who did not marry American men married, in order: British, Caucasian-Hawaiians, Germans, Hawaiians, Portuguese.

LITERATURE

DEMOGRAPHY

ON THE RATE OF GROWTH OF THE POPULATION OF THE UNITED STATES SINCE 1790 AND ITS MATHEMATICAL REPRESENTATION. By Pearl (Raymond) and Reed (Lowell J.)—*Proc. Nat. Ac. Sc.*, 1920, VI, No. 6, 275-288.

A mathematical paper, in which the authors advance an interesting hypothesis as to the law of population growth, with application to the population of the United States. They show that the hypothesis "even when fitted by a rough and inadequate method, so closely describes the known facts regarding the past history of that growth, as to make it potentially profitable to continue the mathematical development and refinement of this hypothesis further. There is much that appeals to the reason in the hypothesis that growth of population is fundamentally a phenomenon like autocatalysis. In a new and thinly populated country the population already existing there, being impressed with the apparently boundless opportunities, tends to reproduce freely, to urge friends to come from older countries, and by the example of their well-being, actual or potential, to induce strangers to immigrate. As the population becomes more dense and passes into a phase where the still unutilized potentialities of subsistence, measured in terms of population, are measurably smaller than those which have already been utilized, all of these forces tending to the increase of population will become reduced."

The theory leads the writers also to the conclusion that "the maximum population which continental United States, as now areally limited, will ever have, will be roughly twice the present population."

TERCER CENSO DE POBLACIÓN DE LOS ESTADOS UNIDOS MEXICANOS.—Méx., 1918.

According to this census the total population of Mexico was, in 1910, 15,160,369, of which 13,143,372 whites, 1,960,306 Indians and 56,691 foreigners. The latter figures, as justly pointed out by Ethnos (1920, I, No. 2, 45) are grossly erroneous. They are based on language qualifications, all those who spoke more or less Spanish having been classed as "whites." There is an urgent necessity of replacing this fallacious criterion by that of racial characteristics of the population, in which the Indian blood still far outweighs the white.

ANTHROPOLOGY OF THE UNITED STATES

PORTRAITS OF EARLY AMERICANS. By Woods (F. A.)—*J. Hered.*, 1919, x, 212-222.

The paper is a review, with supplementary remarks, of A. K. Bolton's "The Founders: Portraits of Persons Born Abroad Who Came to the Colonies in North America before the year 1701" (2 vols., Boston Athenæum, 1919). The author points to the usefulness of scientific study of physiognomy, particularly in older photographic portraits. He expresses the belief that the study of early American portraits and their contrast with more recent ones, may "enable us actually to see human evolution taking place."

AMERICAN INDIAN

BIBLIOGRAPHIE AMÉRICANISTE. By Rivet (P.)—*J. Soc. Américanistes*, Paris, 1919, XI, 677-739.

A very useful list of anthropological publications relating to the American continent which have appeared during the war.

INDIAN VILLAGE SITE AND CEMETERY NEAR MADISONVILLE OHIO. By Hooton (E. A.)—*Papers Peabody Mus. Am. Arch. & Ethnol.*, Cambridge, Mass., 1920, VIII, No. 1, 137 pp.

The examination of the skeletal remains of 217 individuals from an Indian cemetery near Madisonville, Ohio, gave Hooton the following results:

Summary of Measurements and Observations—"A slight degree of unintentional occipital deformation is very common in the Madisonville series, but this is pronounced in a few cases only. Apparently it has affected brachycephalic crania much more than dolichocephalic crania, and probably no crania have been changed from the dolichocephalic class to the brachycephalic class through this agency. No frontal deformation occurs.

About three-fourths of the crania are brachycephalic, and the remainder are mesocephalic, with the exception of two which are dolichocephalic. Three-fourths or more are hypsicephalic and the rest orthocephalic. The breadth-height index is medium in about half of the series and low in the majority of the remainder. The cranial capacity is well up to the average for Indians. The skull walls are not extraordinarily thick. The forehead is a little narrower than average for Indians.

The faces are broad and quite short; the majority being euryprosopic and the rest mesoprosopic. The orbits are variable, but the majority are chamaeconch or microseme. The nose is short and broad, and

platyrrhine indices are in the majority. There is some alveolar prognathism but practically no facial prognathism. The palate is brachyuranic and the lower jaw is short and broad. . . .

The frontal region is medium or low in height, medium or narrow in breadth and medium or receding as to slope, except in females, who exhibit more instances of bulging frontals.

The sagittal region is medium or broad with little development of the median sagittal elevation. Temporal and occipital regions are variable, as is natural in a mixed group. In about two-thirds of cases the sutures are simple in serration, and in the rest medium. Obliteration usually begins in the sagittal suture and the pterions are almost invariably of the broad H form. Sutural bones are very common. Parietal foramina are few and small; retromastoid foramina exceedingly variable. The mastoid processes are usually rather small or medium in males; in females they are often rather large for the sex.

Brow ridges are not unusually large except in a few cases. Frequently they are submedium in development, even in males. Orbits are usually low and oblong in shape with rounded corners. The nasion depression in both sexes is poorly marked, often entirely absent. The nasal bridge is variable in breadth and height, but medium in about half of all cases. Convex and concavo-convex forms are most common. The nasal spine is usually poorly developed and the lower borders are frequently indistinct. On the other hand subnasal grooves or fossae are uncommon.

Malars and zygomae are medium or large in males as characteristic of American Indians, but in the females frequently small. Depth of suborbital fossae is variable. The palate is prevailingly parabolic, sometimes U-shaped or elliptical.

The teeth show marked tendency toward cusp reduction and suppression of third molars. Usually they are not large. Decay and loss in life are frequent.

The glenoid fossae are of medium depth or more; dehiscences in the floor of the auditory meatus are common. The middle lacerated foramina are submedium to medium in size; the depression of the petrous parts is small or medium; the posterior lacerated foramina are prevailingly medium in size, but frequently small, and, when of unequal size, the right is usually larger.

While the mandibles are usually of medium size and medium development in the majority of cases as regards points of interest, there is a large sub-group in which the prominence of the chin is submedium,

and the development of the mylo-hyoid ridge is submedium. The genial tubercles are prevailingly small. . . .

The femora indicate a stature of about 167 cm. for males and 155 cm. for females which is a little above average for Indians but not tall. The long bones do not indicate especially pronounced muscular development but about average for Indians. The limb proportions approximate to those generally observed in American Indians. Platymeria and platynemia are not pronounced except in individual cases.

The Madisonville crania are less strong and rugged than those of the Tennessee Stone Grave group and differ from them in many respects, but particularly in lessened height of the cranial vault, of the face and of the mandible, in our series. The Tennessee group also contains a large majority of brachycephals. There is little doubt that the Madisonville site was inhabited by a people in whom a preponderance of physical characters belonging to the southern and eastern brachycephalic group of Indians was united with an admixture of modified characters originating in the eastern dolichocephalic group. This group seems to have been the result of long contact rather than a primary mixture. Probably its physical affinities with groups as yet unstudied, in Ohio and Indiana, are closer than with the Tennessee Stone Grave group, or with the Iroquois and other eastern groups."

NATIVE CEMETERIES AND FORMS OF BURIAL EAST OF THE MISSISSIPPI. By Bushnell (David I., Jr.)—*Bull. 71, Bur. Amer. Ethnol.*, Wash., 1920, 160 pp., 17 pl., 17 fig.

A creditable publication which will be useful to all branches of American anthropology. It is hoped that it may soon be followed by a similar account of burial customs of the regions west of the Mississippi. The variety of modes of burial, and the frequency of secondary burials, are striking.

THE MEDICAL HISTORY OF ISHI. By Pope (Saxton T.)—*Univ. Cal. Publ's in Am. Archaeol. and Ethn.*, 1920, XIII, No. 5, 175-213, pls. 38-44, 8 fig.

The paper records observations on Ishi [who was the last though perhaps not quite full-blood survivor of the Yahi tribe] in his illness, on his personal habits, on his disposition and mentality, and on the results of the post-mortem examination. It gives also some measurements, but does not enter into critical discussion. The report makes an interesting reading, and arouses a desire for more similarly detailed and careful observations on individuals of other races than our own.

NOTES

ANTHROPOLOGICAL NOTES FROM CHINA.—Early in October a meeting of the Council of the Anatomical and Anthropological Association of China was called to arrange regular meetings for the purpose of reading and discussing papers. It was decided that such meetings should be held in Peking on the last Friday of each month.

The first monthly meeting of the season was held on October 29th in the Anatomical Lecture room of the Peking Union Medical College. Dr. Davidson Black gave a talk on the significance of certain endocranial markings in man and the importance of endocranial anatomy from the standpoint of Anthropology, illustrated by means of lantern slides and specimens. Abstract:

The relations of the skull to the brain in phylogeny were first briefly reviewed, attention being drawn to the strong influences exerted by cerebral and cerebellar expansion in determining the architecture of the cranial portion of the mammalian skull. The relations of the occipital bone to the underlying brain in man were specially referred to, since the growth of the endocranial surface of this bone is directly influenced by both cerebrum and cerebellum. Close and intimate association of the caudal poles of the cerebrum to the superior occipital fossae obtains in this region, the characteristically asymmetrical areas in contact with the occipital cerebral poles being separated from one another by the groove for the superior sagittal sinus. Below the grooves for the transverse sinuses the inferior occipital fossae are less subject to asymmetry and are in most cases separated from one another by a well marked internal occipital crest to which in the recent state the falx cerebelli is attached. The crest and falx cerebelli are structures found only in man and the large anthropoids, the gibbon (*Hylobates*) alone among the latter lacking these structures. In all other mammalian forms this region of the occipital bone is excavated more or less deeply to lodge the postero-median cerebellar lobule, the resulting fossa being termed for this reason the vermiform fossa. In from 4 per cent. to 6 per cent. Europeans examined a fossa occurs which in respect to form and location is identical with the vermiform fossa of many lower mammals though it serves for the lodgement of no part of the postero-median lobule of the cerebellum. The fossa in question is to be regarded as an expression of atavistic forces which become manifest in this region owing to the changes brought about in the endocranial relations, due to the great development of the cerebellar hemispheres. Much concerning the function and organization of the brain may be learned from a study of its external form and many details of the latter may be identified from the study of the inside of the skull alone. In the case of man's forerunners and extinct races of mankind all information as to their brains must be obtained from a study of the skull parts that remain preserved by various means. Professors Boule and Anthony of Paris have recently summarized the findings that have resulted from the study of the endocranial casts of Neanderthal man and it is evident that results of great value have been brought to light by this means. Much however remains yet obscure that may eventually be made plain only by more extensive studies of the endocranial anatomy of the various races of mankind living today. In comparison with the vast population of their country less is known of the endocranial anatomy of the Chinese than of that of any other living race.

Physical Anthropology has been made a part of the curriculum in

the newly established Harvard-Forsythe Graduate School of Orthodontia. The course is given by Dr. E. A. Hooton of Harvard University. It consists of lectures on the evolution of Man from the Primates with special reference to the development of the human skull and human dentition, variations of the face and palate, anthropometric and statistical methods of dealing with orthodontic problems. The course also includes laboratory work on the cranial collections of the Peabody Museum, and reading designed to furnish a proper anthropological background for scientific research in this important dental specialty.

The newly organized (post graduate) School of Diplomacy, Jurisprudence and Citizenship, of the American University, Washington, D. C., includes a course in Anthropology, by Dr. Hrdlička, on Man's Evolution, Differentiation and Spread, and on the Racial Origins and Composition of the various Nations.

The Department of Archaeology of Phillips Andover Academy has concluded an arrangement with the Peabody Museum of Harvard University, by which the skeletal collections acquired in the excavations at Pecos, New Mexico, are to be deposited in the Peabody Museum. Excavations of two seasons on this important prehistoric and historic site have already yielded more than 650 skeletons from seven different cultural strata. The work will be continued for several more seasons and should provide the largest skeletal series ever taken from a single site in the United States.

Louis L. Sullivan, of the American Museum of Natural History, has been given charge of the work in Physical Anthropology in connection with anthropological research in Polynesia that is to be carried out under the auspices of the Bishop Museum of Hawaii. Mr. Sullivan has been granted a leave of absence from his duties in the American Museum and has made his headquarters in the Bishop Museum at Honolulu.

As a result of preliminary conferences held in Paris during the earlier part of September, there has been established the "Institut International d'Anthropologie." The headquarters of the Institute are at the Ecole d'Anthropologie, 15, Rue de l'Ecole de Médecine, Paris.

The XV International Congress against Alcoholism has held its session under Governmental auspices in Washington, September 21 to 26. There were a number of papers of anthropological interest on the program, some of which were: *Alcohol and Criminality*: By Dr. Aug. Ley, Professor of Psychiatry at University of Brussels, Belgium. *Heredity and Environment as Causative Factors in Alcoholism*: By Prof. Aschaffenburg, Director of Psychiatric Clinic, Cologne. *Latest*

Scientific Investigation in America of the Action of Alcohol on the Brain, the Nervous System and Heredity: By Prof. Charles R. Stockard, Cornell University. *The Results of the Measures against Alcoholism in Europe During the War:* By Mr. Larsen-Ledet, Aarhus, Denmark.

A Eugenics Committee has been appointed by the National Research Council for the organization of the International Congress of Eugenics to be held in New York, September, 1921. Dr. C. B. Davenport is chairman of the committee.

SUMMER SCHOOL OF EUGENICS IN ENGLAND.—The third annual summer school of Eugenics and Civics was held at Herne Bay College, Kent, from July 31 to August 14 inclusive. The school, which is under the management of a special committee headed by Major Leonard Darwin, provides courses of instruction on Heredity and Eugenics and Application of Eugenics, besides related subjects, to social workers, teachers, lecturers, and medical and other students.

DR. RAYMOND PEARL, director of the department of biometry and vital statistics, school of hygiene and public health, Johns Hopkins University, Baltimore, gives a course of Lowell lectures in Boston beginning on December 1. The subject is "The Biology of Death," and the subjects of the separate lectures are: (1) Senescence and death; (2) The chances of death; (3) The causes of death; (4) Correlation of death rates; (5) Inheritance of life duration; (6) The trend of mortality and some of its consequences.

DR. ALEŠ HRDLIČKA has received the title of Doctor *honoris causae* from the Prague University.

PROFESSOR ROBERT BENNETT BEAN has been named a Corresponding Member of the Società Romana di Antropologia.

Professor Eugene Fischer has been appointed Director of the Institute of Anatomy at Freiburg in Baden, Germany. It was this Institute which during the war was accidentally bombed and set on fire, with the resulting loss of a larger part of its valuable collections. The Institute is to be rebuilt and rehabilitated. For the latter purpose it has recently received a valuable gift from Professor A. Haberer, consisting of his rich biological collections from Kamerun, including many specimens from the anthropoid apes.

✠ DAVID VON HANSEMANN.—German science, including anthropology, has suffered a still further grievous loss in the death, on August 28, and after a protracted illness, of Dr. David von Hansemann, Professor of Pathological Anatomy on the Berlin University. Professor von Hansemann was an authority on diseases of bones, and was deeply interested in racial pathology. In his laboratory at the Rudolf Virchow Hospital, he assembled a valuable cranial and skeleton collection showing various diseases.

✠ SAMUEL A. LAFONE QUEVEDO.—Professor Lafone Quevedo, Director of the Museo de la Plata, a distinguished linguist, archeologist and a warm friend of physical anthropology, died in advanced age at La Plata, June 18. In August the Council of the University selected Dr. Luis María Torres, Chief of the Departments of Archeology and Ethnography in the Museum, and Professor of American Prehistory at the University, as the new Director.

✠ CARL TOLDT.—Dr. Carl Toldt, emeritus professor of anatomy at the University of Vienna and a former president of the Anthropological Society of Vienna, died in his 81st year on November 14, 1920.

Augusto Tamburini.—The last number of the *Rivista di Antropologia* to reach this country brings the announcement of the death of Professor Augusto Tamburini, one of the foremost psychiatrists of Italy and a past President of the Società Romana di Antropologia.

AN APPEAL FOR PUBLICATIONS FROM CZECHOSLOVAKIA.—Within the two brief years of its existence the new Czechoslovak Republic has established two new Universities—one at Brno (Brünn) and the other at Bratislava (Pressburg), besides a whole series of high schools and other institutions of learning. In addition, the University at Prague finds itself this year with a nearly redoubled number of students, of whom there are now over 10,000. With the generally and greatly reduced exchange value of European currency, it has become exceedingly difficult for the scientific men of these Universities to provide themselves with scientific literature published since 1914, and they appeal to their American colleagues for all possible help in this direction. The publications needed are those reporting original research, in all branches of science; sets of reprints of individual workers and Journals will be particularly valued. Besides these any reprints or scientifically valuable volumes that can be spared will be welcome, even though they may be of much older dates. The publications should be sent to the Czechoslovak Legation, 1734 N. Street, Washington, D. C., from where they will be forwarded to the men and Institutions most in need of them, through the International Exchange Bureau of the Smithsonian Institution; or they may be sent to Dr. A. Hrdlička, U. S. National Museum.

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